Vol. XXIII, No. 8
DECEMBER 1956

THE SCIENCE TEACHER

- What Happens If . . .
- High School Chemistry: Keeping the Course Up To Date
- Teaching Radio in High School Physics
- The ABC's of Bacteriology
- Winter Nature Study

JOURNAL OF THE NATIONAL SCIENCE TEACHERS ASSOCIATION

New Editions for 1957

SCIENCE IN EVERYDAY LIFE

Second Edition

Obourn, Heiss, Montgomery

In bringing this ninth grade general science text up to date, the authors incorporate the many remarkable scientific advances which have been made in recent years. Unit 9 is expanded to two chapters, one dealing with conventional sources of energy, the second with atomic energy. All of the problem-solving exercises at chapter ends are revised so that each one stresses a particular step, skill or technique in problem solving. The text's proven approach, its emphasis on learning by doing, remains unchanged.

Published Spring 1957

CHEMISTRY—A BASIC SCIENCE

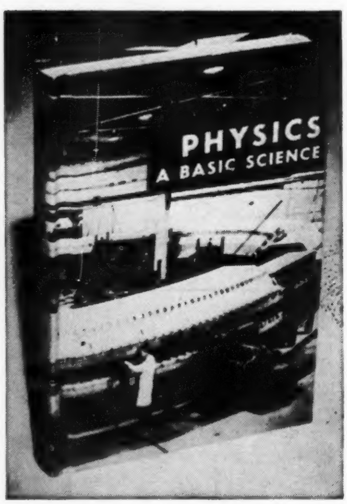
Fourth Edition

Hogg, Alley, Bickel

The fourth edition of this text, formerly entitled *Chemistry: A Course for High Schools*, is revised throughout in order to reflect the latest advances in chemistry. The unit on nuclear theory is greatly expanded to include the many developments and discoveries of the past few years and to emphasize the peaceful uses of atomic energy. The chapters on the atomic theory and chemical arithmetic are completely rewritten.

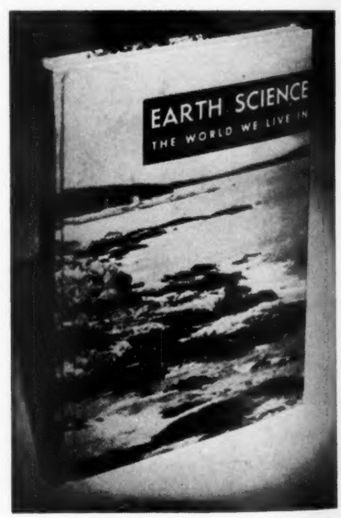
Published Spring 1957

P.S. Don't forget our fine physics and earth science texts:



PHYSICS
A Basic Science
Third Edition
Burns, Verwiebe, Hazel, Van Hooft

EARTH SCIENCE
The World We Live In
Namowitz, Stone



D. VAN NOSTRAND COMPANY, INC.

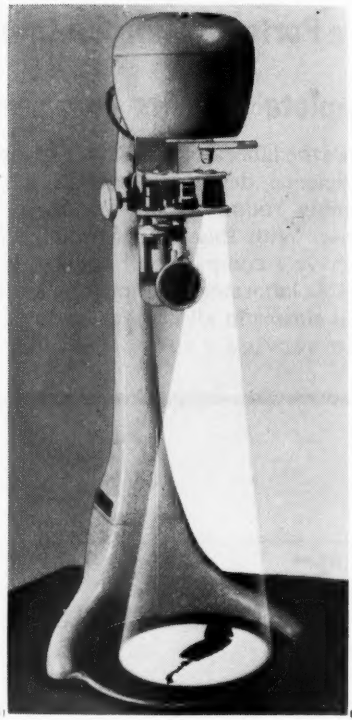
120 Alexander Street **Princeton, New Jersey**

SVE

SEOSCOPE

MICROPROJECTOR

for study of "Live" or inanimate
science specimens

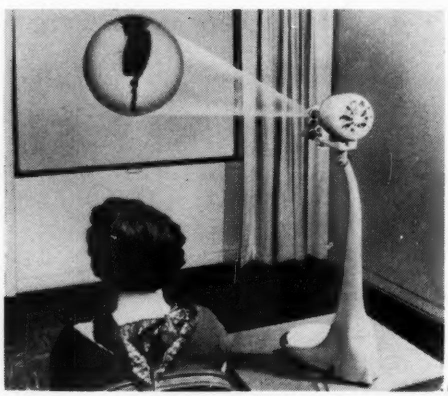


For close-up studying and copying.

Designed especially for classroom use, the Seoscope takes the place of individual microscopes for group study requiring low magnification, and provides these added advantages:

- **Only one specimen required for class study.**
- **The teacher knows what the class is seeing and can point out special-interest areas.**
- **Specimen may be projected on screen or on built-in 8-inch base area.**
- **More specimens can be shown in class period than is possible with individual microscopes.**

The entire class views the same specimen at the same time!



For class study.

25mm, 16mm and 10mm lenses (standard equipment) provide magnification up to 50 times on base area; up to 32 times for each foot of projection to screen. Easy to use polarizing set included. Complete, with 3 objectives as above, Polaroid set, plastic cover.

$139.50

For complete information call your authorized SVE dealer or write:

SOCIETY FOR VISUAL EDUCATION, INC.

(A BUSINESS CORPORATION)

1345 Diversey Parkway, Chicago 14, Illinois

A Subsidiary of General Precision Equipment Corporation

PHOTO BY HALSMAN

THIS MONTH'S COVER . . . is a scene in a schoolroom at the Midtown Ethical Culture School in New York City, where the faculty believes that a child's natural curiosity finds a valuable outlet in science studies. Looking at this photograph and the intent expressions of the children, one can almost hear them saying, "You can take the rabbit out of his cage. His fur is so soft. You can *feel* his heart beat."

Believing, also, that curiosity is one requirement of a scientist and that science interests should be stimulated at a very young age, the Ethical Culture School has set up a science laboratory for its young students. Cornelius Denslow has written a report on how this program is carried out and what it is accomplishing. Titled "What Happens If . . .," it is the lead article in this issue and begins on page 385.

Readers' Column

Enclosed are 27 Active Membership application forms which our sales force have recently completed and returned to me for submission to the National Science Teachers Association. Also enclosed is our check for the memberships.

The men will be proud and very happy to belong to your organization and Henry Holt and Company is privileged to give their support to it. At our last national sales conference, our representatives in the field expressed the unanimous feeling that they would consider it their privilege to be able to belong to and support such a fine organization in the field of science education, and it was their hope that the Company would take out memberships for each one of them.

Gerard S. Walker
School Department
Henry Holt and Company, Inc.
New York City

As a member of NSTA, I read in the September journal the article, "Thrilling New Advances in Visual Aids," by Allan B. Burdick. I certainly agree with him. From my own experience, I know that students remember longer what they see rather than what they only hear. Consequently, I always try to illustrate my lectures with slides or films.

Unfortunately, I cannot find any 35 mm slides in color or black and white on the following subjects: archaeology, paleontology, speleology, volcanology, the mystery of the sea, and earthquakes. I wrote to many companies for such slides but they all replied they did not have them in stock.

Would you please, therefore, print this letter in *The Science Teacher*. If any NSTA members have such slides or know where I could obtain them, I'll appreciate their writing to me.

Edouard Gosselin
Institute of Physics
University of Montreal
Montreal, Canada

Please find enclosed a cheque for my 1957 subscription. I would like the Elementary School Science Bulletin for each issue.

Thank you for the help your association has been to me during the past two years.

Sister Mary Charles Delaney
Dominican College
Fort William Park
Belfast, Ireland

I'd like to take this opportunity to tell you that your magazine is excellent. In addition, the material sent from time to time has proven most valuable and practical to use. I've also recommended to several schools that they take the library subscriptions.

Andrew James Peters
Bloomfield Junior High School
Bloomfield, New Jersey

It is with great pleasure that I renew my membership in the NSTA.

Last year was my first year of teaching and the materials that were sent to me helped me a great deal in starting a file of articles. If there is any way in which the organization would like me to help, I would be glad to offer assistance.

LeRoy H. Anderson
Bedford, Iowa

For Your Calendar: December 26, 1956 is the date of the annual Conference on Scientific Manpower, held in New York City in conjunction with the annual meeting of the American Association for the Advancement of Science. Sponsors of the Conference are the Engineering Manpower Commission, the Scientific Manpower Commission, the Office of Scientific Personnel of the National Research Council, the National Science Foundation, and the AAAS Section M-Engineering.

THE SCIENCE TEACHER

The Journal of the National Science Teachers Association, published by the Association, 1201 Sixteenth Street, N. W., Washington 6, D. C. Membership dues, including publications and services, $4 regular; $6 sustaining; $2 student (of each, $1.50 is for Journal subscription). Single copies, 50¢. Published in February, March, April, May, September, October, November, and December. Editorial and Executive Offices, 1201 Sixteenth Street, N. W., Washington 6, D. C. Copyright, 1956 by the National Science Teachers Association. Entered as second-class matter at the Post Office at Washington, D. C., under the Act of March 3, 1879. Acceptance for mailing at special rate of postage provided for in the Act of February 28, 1925, embodied in paragraph (d), Section 34.40 P. L. & R. of 1948. Printing and typography by Judd & Detweiler, Inc., Washington, D. C.

MEMBERSHIP

The membership year coincides with the calendar year. New entries during the fall months extend through the following calendar year. Library and elementary school subscriptions coincide with the school year or run for one year from date of entry.

Active Membership	$4.00
Sustaining Membership	$6.00
Student Membership	$2.00
Library Subscription	$5.00
Elementary School Subscription*	$5.00
Life Membership	$100.00

(payable in annual installments of $10.00)

*** Includes the *Elementary School Science Bulletin* in quantity lots.**

REMINDER TO *TST* READERS AND SUBSCRIBERS

This is the last issue of Volume XXIII and of the calendar year. Publication will be resumed with the February 1957 issue, which the editors plan to have in the mail for you by February 1.

Editor's Column

I have recently had the stimulating, provoking privilege of watching two science teachers run their classes through "the first marking period" of the school year. Mr. Chem and his students began by sort of talking at random about this and that; somehow got onto the question, "How do scientists know about atoms and molecules and other things too small to see?"

They spent most of the first week putting oil drops on containers of water (including an eight-foot diameter plastic wading pool brought into the classroom) and then computing the thickness of the film. The students found a *need* to learn about measurements and the convenience of the metric system. They learned something about how scientists go about their work. Not until the end of the second week of school did Mr. Chem give out textbooks; but meanwhile there had been several days of activity in the chemistry laboratory.

Mr. Bio, for his part, kicked off his class with a tough homework assignment the very first day. "Define biology. . . . Find ten other 'ologies' and define each one." The first unit was on *Insects*. The main goal seemed to be to make a grade: 30 insects in a collection for a C, 40 for a B, and 50 for an A. (Thousands of students doing this does, of course, contribute to a measure of control over the insect population.)

Meanwhile, the students were memorizing the orders of insects, the chief characteristics of each order, and three examples. Weekly tests during the first marking period all called for repeating memorized material of this kind. There was one laboratory period to draw the parts of a grasshopper; another to look through a microscope, make a drawing of it, and label the various parts. I had a little talk with one of Mr. B's students who got a D at the end of the first marking period (and B's in all other academic courses). His mark was the average of five tests on which he got one A, two B's, and two E's. The student (?) thought he liked science but he was already sure he didn't like biology. Clearly, here is a boy who is *not* a future scientist.

Or is he? How do we know a future scientist when we run across one? How do we instruct and encourage such students? How do knowledge of subject matter and knowledge of the psychology of learning and of teaching techniques affect the competency of a science teacher? What *are* the elements of competency in science teaching? Where and how do science teachers learn to be *effective* science teachers? What should a student have to do to succeed (get an A or B) in science, and what should he have to do to fail (get a D or an E or F)? Does he succeed or fail if he gets a C—which in most school systems means "Satisfactory" or "Average" work?

What is the role, what are the opportunities and the roadblocks of the science supervisor in the upgrading of instruction in science? Who is *concerned*, or worried, about the quality of instruction in the science classroom? Who has *authority* to go in and tell a teacher he seems to

(Please continue on page 429.)

THE SCIENCE TEACHER

Vol. XXIII, No. 8 **December 1956**

Articles published in THE SCIENCE TEACHER are the expressions of the writers. They are not a statement of policy of the Association or the Magazine Advisory Board.

The National Science Teachers Association is a department of the National Education Association and an affiliate of the American Association for the Advancement of Science. Established in 1895 as the NEA Department of Science Instruction and later expanded as the American Council of Science Teachers, it merged with the American Science Teachers Association and reorganized in 1944 to form the present Association.

WHAT HAPPENS IF—?

By CORNELIUS DENSLOW

Teacher of Science, Midtown Ethical Culture School, New York City

MY fourth-grade class was busy at the laboratory tables when Jimmy came over and asked for a saucepan. "I want to boil some water," he explained.

I gave him a quart pan and a few minutes later strolled over to see what he was up to. In the briskly boiling water I could see specks of sawdust whirling, and at the bottom of the pan, two slightly disintegrated dog biscuits. "What's that for?" I asked.

"I wanted to see if sawdust and dog biscuits dissolve in boiling water," Jimmy replied solemnly.

"O.K.," I said. "That's an interesting experiment, only next time you might try using just a little bit of each in a test tube. Saves time—and dog biscuit!"

Jimmy's "experiment," though a little unusual, is quite in line with the spirit of "what happens if—?" which permeates the science program carried on at the Midtown Ethical Culture School. One of the three Ethical Culture Schools in New York City, which also include the Fieldston School and Fieldston Lower School in Riverdale, Midtown's classes range from preschool through sixth grade.

Curiosity Kills No Cats

In these schools the science laboratory is thought of as a place where a child should be able to satisfy his curiosity about many things. Curiosity is a natural asset of every child, and certainly from the point of view of science, his most precious one. It is through curiosity that the human race has progressed beyond other animals, through it that science has made its tremendous advances. Yet, too often, the curious child is discouraged in his pursuit of knowledge by adults who forget the part that curiosity has played in their own learning.

Even a school laboratory, where the spirit of inquiry should be preeminent, may degenerate into a place where the student does what he is told and goes away without having experienced any of the joy of discovery. In our laboratory curiosity kills no cats. It is the foundation of our teaching, and we do our best to arouse and foster it. The children's own interests dictate much of what they study, and they are encouraged to work on their own as much as possible.

We believe that the most valuable result of a child's early experience in the many fields of science is the development of a genuine liking for science and a desire to find out more, rather than the acquisition of predetermined facts or procedures. Information per se is not understood or retained unless the child is ready to receive it. Only when it satisfies a genuine curiosity is it truly assimilated.

Our teaching of techniques, as in the case of Jimmy's experiment with the dog biscuit, comes out of the children's natural desire to learn better ways of doing things.

Science "Free Periods"

Our "free periods" in science, where each child may work on his own experiment, are very popular with the children. Their enthusiasm carries them through projects that might seem only boring if they were imposed from above. I feel that it is an important part of a child's science training to be able to follow up some of his own ideas. This doesn't mean that instruction, demonstration, or lectures are obsolete—they have their own essential time and place.

With freedom to experiment comes an added responsibility on the part of the teacher to see that the results of their curiosity do not endanger the young researchers. For this reason we have only half a class (about ten children) in the laboratory at a time. One must be on the alert to keep track of and assist even as few as this when each is engaged on an individual experiment. Then, too, with a small group the children can get materials and advice without the frustrating waits that are inevitable when one science teacher is trying to handle a large class.

To assist their efforts to find out "what happens if — ?" our students have access to microscopes which open up a wonder world for those who examine the pond-water cultures we keep in the laboratory. Slide-making equipment is available to those who wish to make permanent slides for their own use. Many techniques in microscope work are easy enough for fairly young children,

PHOTOS BY HALSMAN

The fifth grade experiments with the properties of oxygen.

while the more complex techniques present a challenge to the older child.

A youngster interested in electricity may use a low-voltage current source which is perfectly safe and yet can operate small motors, bells, lights, buzzers, and other small equipment. This current comes from dry cells or from our converter-transformer combination which is turned on, on request. An amazing array of apparatus is sometimes set up by ambitious students, who at the end of the period regretfully disassemble the masterpieces and put the component parts back in their proper storage places. Freedom to use equipment stimulates the students' interest in a great variety of subjects.

Chemistry, of course, attracts many youngsters, but at this age they need careful supervision. They love to dump a lot of chemicals together "just to see what will happen." Here we must curtail their freedom and channel their interest. For this reason most of our work in chemistry consists in following out known procedures—making inks, freeing oxygen, crystallizing chemicals from solutions, separating mercury from mercuric oxide, etc. Sometimes a child may find out from an outside source how to do an experiment which we may then carry out in our laboratory, both to his and the other children's interest.

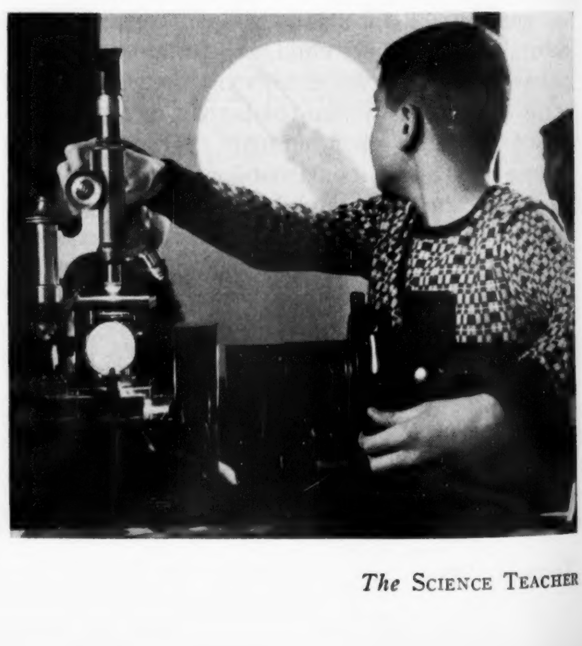
Amateur photographers find many interesting subjects among the animals we always have in our laboratory, or among their friends at work there. They learn to develop their own film in the darkroom and to use our equipment for enlarging and contact printing. By closing our dark shades we can convert the whole laboratory into a rough and ready darkroom. Overlapping board frames around the shaded areas make the room sufficiently light-tight so that we can teach the rudiments of photography to a group which would be far too large to crowd into our little darkroom.

The animals that live in our laboratory usually include specimens from all the groups of vertebrates and some of the invertebrates. Many may be handled and studied at close range. A child may "adopt" an animal and come daily to feed and care for it. Sometimes this leads to interesting relationships between children of different ages, as when Charles, a fifth-grade boy, allowed a first-grade class to borrow his adopted hamster. The younger children were delighted when Charles continued to visit his hamster while it was in their custody.

Third-grade children manage an aquarium service for the school. They install an aquarium in any of the 27 classrooms and offices which request it, and service it daily. This includes inspection, cleaning, feeding, and removing sick fish to their home room for hospitalization. In the process the children learn how a siphon works, the weight of water and its relation to liquid measure, and other items of scientific interest, including how to examine a fish's circulatory system under a microscope without hurting the fish.

The third grade also maintains an animal service. In this, they will demonstrate to the younger students how to care for animals in the science laboratory.

With the microprojection apparatus, which children at the Midtown Ethical Culture School can handle themselves, a tiny beetle appears on the screen as a fascinating monster.



This year we have enjoyed the experience of growing plants from a variety of seeds supplied in the laboratory. The children make their own seed boxes from cardboard folded to make a container, then dipped in melted paraffin to make them waterproof.

The scientific spirit in children at an elementary school level is not always "pure." For many children the pursuit of knowledge is not enough—they want the tangible evidence of "something accomplished, something done" to keep and take home with them. It may be a small electric motor made from a few nails, a cork, and a piece of glass tubing. But with proper wiring it will really run. Again, what satisfaction to write a letter with ink you have made yourself; even to take the ink home in a bottle brought to school for the purpose! A crystal radio set, a homemade thermometer, a compass made from an index card, a snap fastener, a thumb tack and a couple of needles—these are treasures which symbolize not only a momentary pride of achievement, but also, we hope, an enduring interest in science.

Winter Nature Study

By ROBERT R. SCHMATZ

Assistant Professor of Education, College for Teachers, State University of New York, Brockport

ELEMENTARY SCHOOL FIELD TRIPS are popular expeditions on the relatively few days of pleasant weather in early fall or late spring. Most teachers will agree on the value of these out-of-doors trips, during which they can observe their young students actively engaging in exploration of the wonders of nature. Rarely, however, do teachers utilize the cold, crisp days of winter to make such field trips. Yet, the snow-covered fields and seemingly lifeless woods and streams abound with animal life which has adjusted to the difficult conditions created by the ice and the snow.

An exploratory trip to a nearby stream will reveal that beneath the cover of snow, the water is still flowing. An air space between the snow and water will also be seen. Along the banks, places where roots have been dug by muskrats may be noted. If these are discovered, pools of water nearby will be found to be clogged with chewed roots and vegetable matter from these fur bearers.

If the snow is not too deep, places may be located where these animals have left the water in search of food. The tracks of the muskrat are easily identified by the tail mark running between the footprints, and it will be interesting to note that these animals do not wander more than a few dozen feet from the stream and their dens.

In more remote places, mink tracks can be found and the animal's path can be easily followed to where he searched for food the night before. This curious little fellow will have inspected every hole along the banks of the creek in search of clams, frogs, and crayfish.

Incidental learning will take place when rabbit tracks are seen in the brush near the stream. Indeed, the frisky little animal may run out before the children and disappear quickly into the heavier wooded areas nearby.

Other signs which may be seen are the tracks of pheasants, coon, fox, opossum, squirrels, and mice. Closer observation of this wooded, snow-bound area will reveal how the animals are finding food and surviving in their wintry environment.

Outgrowths of this trip could be a unit on fur bearing animals, in which a study of the fur trade in America could be made. Some of the boys might develop profitable and interesting hobbies of trapping. Others could be motivated to read about trapping, the lives of animals, and fiction stories about animal life.

A few possibilities for art lessons could include landscape drawings, modeling of animals in clay, or making labeled drawings of animal tracks. A language activity could be the writing of imaginative tales of animal life during the winter. Reports could be made on how these animals survive beneath the ice and snow during these months.

In cases where severe winter conditions revealed that animals were having difficulty finding food to survive, good conservation practices could be developed by having the class undertake to make some food available for the animals.

The many possibilities of winter field trips are worth-while enough to warrant a venture into the out-of-doors at least once this winter by every teacher.

TEACHING RADIO IN HIGH SCHOOL PHYSICS

By FREDERICK B. EISEMAN, JR.

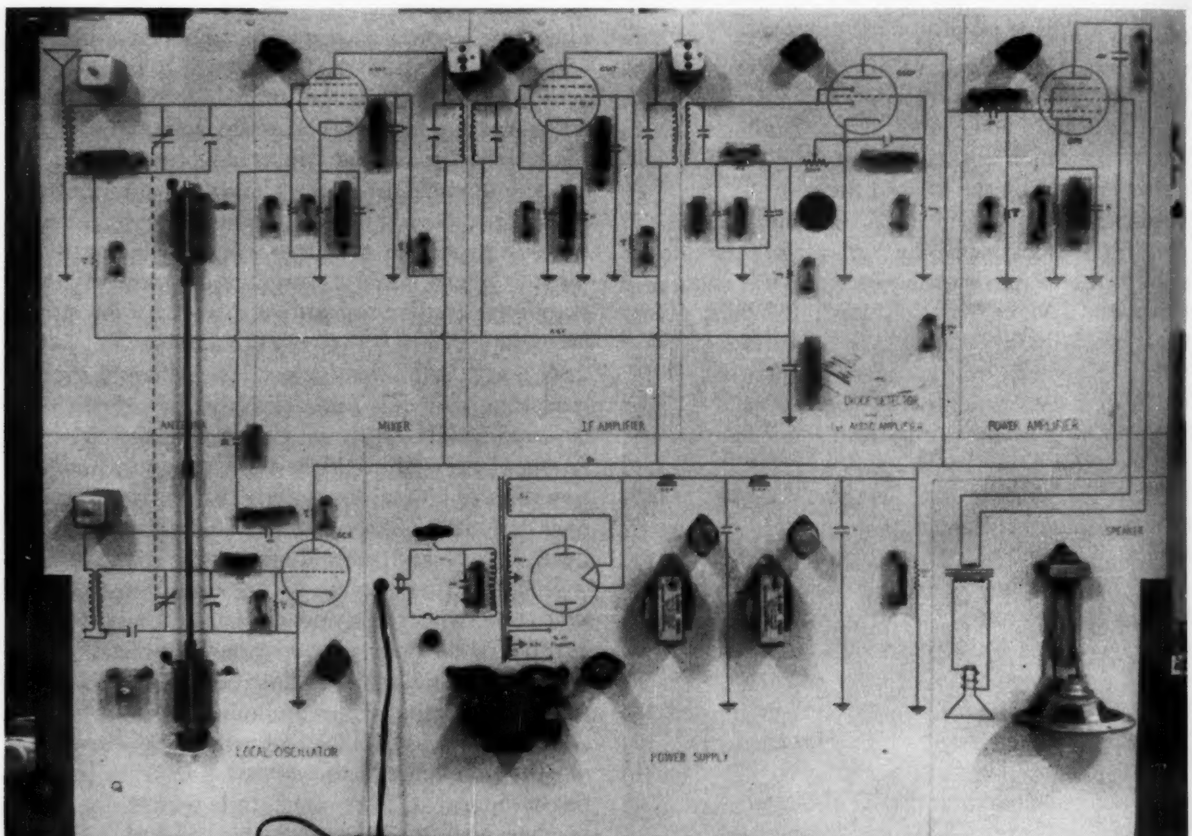
John Burroughs School, St. Louis, Missouri

Electronic devices are becoming such an important tool in modern science that it is high time secondary school physics teachers include a unit on radio and electronics in their courses. If properly taught, this unit need be no more complex than, say, the laws of motion. If improperly taught, the subject matter can mean little to the students.

Actually, many of the important ideas of electronics can be introduced rather naturally in the course of the study of electricity as it is usually taught. For example, the filtering action of capacitors can be demonstrated and explained when the capacitor is studied in connection with electrostatics. The function of by-pass capacitors in bias circuits can be easily taught if AC is studied when the subject of capacitive reactance is undertaken. Most high school physics books at least mention rectification, and the subject of the diode rectifier and thermionic emission can be introduced here. The choke's action in filtering can be studied when emf of self-induction is introduced. In short, when the teacher has finally finished AC and comes around to trying to explain how a radio works, if his thoughts have been pointed in that direction, he will be rather surprised to find that he has already taught most of the essentials. All that remains is to put them all together into a radio receiver or transmitter.

Demonstration and experimental equipment for this area is expensive, somewhat old-fashioned, and rather inflexible. The new Philco demonstrator is excellent, but beyond the budget of most high schools[1]. Therefore, in introducing electronics to students at John Burroughs, it was decided to build the equipment from commercially available parts. The results have been extremely

Figure 1. Superheterodyne Receiver Panel



gratifying. Students followed the construction with interest and profited greatly from the time spent in class on the subject.

Taking the clue from the Philco model, as well as from the commercially available Welch[2] and Stansi[3] equipment, it was decided to mount all of the components on a large panel, preferably vertical, right next to the schematic symbols of the components in the circuit diagram. Using this plan, we constructed a superheterodyne receiver, a TRF receiver, a half-wave diode rectifier, a full-wave two-diode rectifier, a full-wave double-diode power supply and filter, a selenium-rectifier bridge circuit, a single-tube broadcast band transmitter, and an audio oscillator.

The superhet was constructed all on one 3 x 4-ft. piece of ⅛-in. aluminum, supported by four pieces of angle iron. It was decided to make a receiver with a separate local oscillator, so that the confusion of the usual pentagrid converter could be avoided. A perfect circuit was found in the new series entitled *Basic Electronics*[4], a Navy course, now available for civilians. Interested readers will find the complete circuit on page 76 of volume 5 of this book.* As a matter of fact, most of the circuits constructed were taken from this *Basic Electronics* series.

It was further decided to make as many of the parts removable as possible, so that the effect of different values of capacitors and resistors could be demonstrated. This problem was readily solved in the following manner. The component, resistor or capacitor, was mounted on a small piece of transparent polystyrene plastic sheet, ⅛ in. thick. The mounting was accomplished by drilling two $\frac{5}{32}$-in. holes through the plastic separated by a distance slightly greater than the length of the component to be mounted. Through the two holes were inserted the threaded ends of two non-insulated banana plugs, of the type readily available from any radio parts house. The leads of the component were secured around the threaded stem of the plug and held down with the nut that fits on the plug. The plastic was then sanded down to proper and convenient size.

Next to the schematic of the component were drilled two $\frac{5}{16}$-in. holes at a distance apart equal to the separation of the banana plugs on the component. An insulated banana jack was inserted into each hole, red ones for resistors and black ones for capacitors. The plastic front of the jack insulated the jack in front and a fiber shoulder washer in the rear kept the component from grounding out. A solder lug under the nut provided easy connection. For the grounded ends of the components, the shoulder washer was omitted and an aluminum washer substituted.

The whole superhet was laid out in sections across the top of the board and at the bottom, as can be seen in the photograph, Figure 1. Each section of the receiver was outlined in red ink, which does not show up very well in the photograph. The panel was painted with two coats of ordinary white enamel before mounting the components and the wiring schematic was drawn on with ordinary India ink and a lettering pen. When thoroughly dry, the entire receiver was sprayed with Krylon transparent plastic. No attempt was made to trace out the heater circuits, as this would have led to confusion on the front. No wires appear on the front. However, the wiring was completely and neatly done on the reverse side, following as much as possible the paths suggested on the front. The wiring is all color-coded to assist in tracing. The values of the components are lettered next to their schematics on the front.

Rather than use the usual two-gang tuning capacitor, it was decided to use two separate variable capacitors, each used in association with its own circuit. This is reasonable, since the two sections are associated with entirely different circuits, and there is no point in confusing the student on this score. Therefore, tuning capacitors with projections on the rear were necessary because of the need for attaching them together with a shaft and couplings. Bud No. MC 1860 fulfills these requirements. Thus, the antenna and oscillator tuning capacitors remained with their respective circuits on the panel, joined together by a length of ¼-in. brass shaft, held with two shaft couplings to the capacitor shaft extensions.

Because of the tremendous distances separating components that, by all rights should be as close together as possible, it was feared that all sorts of trouble would be encountered. However, by shielding all the grid inputs and by filtering all nearby fluorescent lamps, very little interference is evident. Because of the large distributed capacitance in the long wires, the size of the padder capacitor had to be increased considerably above the 600-mmfd. value suggested in the circuit diagram. An Arco No. 307, with a maximum capacitance of 1180 mmfd., was found suitable. Of course, no dial was easily fitted into this circuit, but the set tunes perfectly from 550 to about 1500

* If access to the text is not possible, the author will be glad to mail a sketch of the circuit, together with component values, upon request. Circuit values and the transmitter circuit mentioned in this article will also be supplied on request.

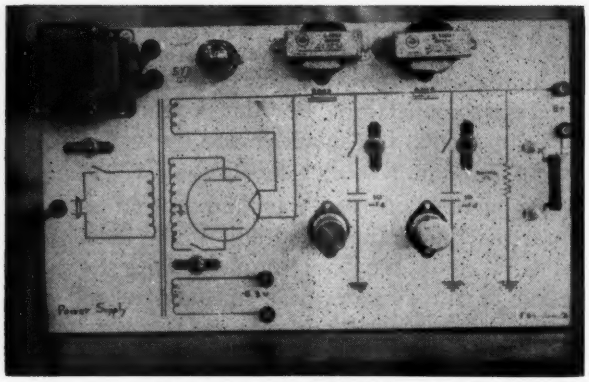


Figure 2. Power Supply Panel

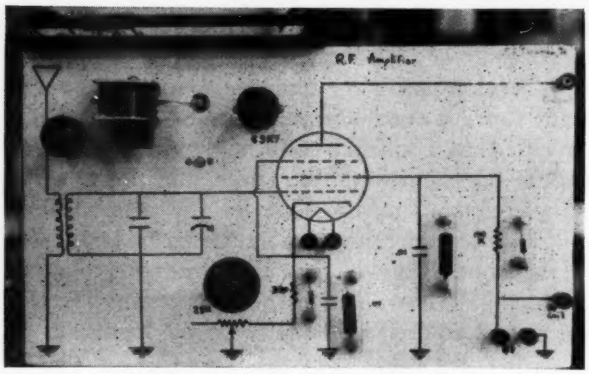


Figure 3. R.F. Amplifier Panel

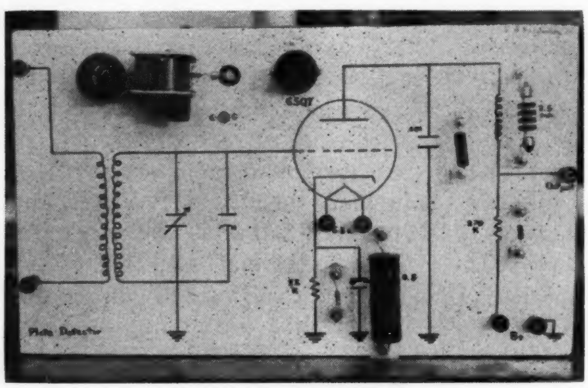


Figure 4. Plate Detector

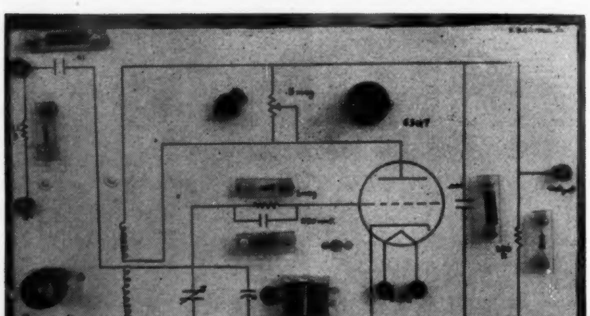


Figure 5. Regenerative Detector

kc. It was aligned with the Heathkit RF Generator and VTVM. The trimmer capacitors were kept separate from the variable tuning capacitors so that their function might be more easily demonstrated. The cost of this superhet could not have exceeded $90, and it is felt that its flexibility far exceeds anything commercially available. An oscilloscope can be connected at any point on the front of the panel, for all components have both leads readily accessible.

The other pieces of equipment were mounted separately on 10 x 17-in. aluminum chassis. The TRF receiver was constructed, following the plans in Volume 5 of *Basic Electronics*. The power supply was constructed on one chassis, following the usual plan of a full-wave rectifier with switches to cut out one of the plates and both filter capacitors, so that the oscilloscope would show the actions of full- and half-wave rectification and capacitor filtering. The photograph of this chassis shows all the important details (see Figure 2). The RF amplifier (Figure 3) follows the usual pattern. Miller series 20, unshielded coils were chosen for their ready visibility. Two detectors were constructed and are interchangeable. Both a plate detector (Figure 4) and a regenerative detector (Figure 5) can be used. The audio amplifier (Figure 6) is just like that on the superhet, using a single 6F6. Each chassis has banana jacks for the 6.3-volt heater supply from the power supply chassis, jacks for the B+ from the power supply, jacks for input from the previous chassis, and jacks for output to the next stage. The connecting wires were made from ordinary No. 18 stranded lamp cord. All the components were made removable, just as with the superhet. The separate nature of these components made it rather difficult to gang the two tuning capacitors, so that a bit of hunting around is necessary in order to select the proper frequencies. The antennas on both the superhet and TRF receivers are of the ferrite rod type.

To illustrate diode rectifying action, a single diode rectifier, using a 1V tube, was constructed to operate directly from the AC power line. Its half-wave output is readily demonstratable with the oscilloscope. The next step is a panel using a transformer with a 1V connected to each end of the transformer secondary. This is shown to give full-wave rectification. Finally, the power supply panel of the TRF can be used to illustrate the more usual double-diode full-wave rectifier.

Another panel with four 500-ma. miniature selenium rectifiers in a bridge circuit was con-

structed to show the action of dry-disk rectification. A switch in one branch of the bridge converts the panel circuit to half-wave rectification.

A panel for testing the characteristics of triodes was constructed, using the same general scheme, from a description of this type of unit in a generally available text[5]. As can be seen in the photograph (Figure 7), the unit can test any of several types of 6-volt triodes, giving ready access to the voltages and currents required. One of the two tubes must be removed before the other can be tested, as their components are wired in parallel.

An audio oscillator of the Armstrong tickler coil variety, very similar to the one used for RF on the superhet, was constructed on another panel, as shown in Figure 8. The feedback capacitor, as all the other components, is removable, giving different audio frequencies for different values of capacitance. The two binding posts permit connection of a regular variable capacitor. This oscillator is powered by the TRF receiver power supply and can be amplified by the TRF audio amplifier. This circuit is studied before the heterodyning action of the superhet is taken up.

Finally, a single-tube transmitter was constructed, using a 117N7 tube as both rectifier and amplifier. The circuit is similar to the one available from Welch[6], with modifications. Surprisingly enough, this simple transmitter with a modest antenna has been picked up more than 500 feet from the laboratory in which it is set up on an ordinary radio at normal volume. The only part that had to be made for this transmitter was the tank coil. For this, 110 turns of No. 30 copper wire on a 1-in. form, center tapped, was found to be satisfactory when used with a 365-mmfd. capacitor.

Armed with all of this equipment, the next chore was to provide the students with some reference material. Our physics text was rather vague on the subject. A little digesting and simplification of ideas was all that was needed, and each student now has a 35-page mimeographed guide to the study of these circuits. After an explanation of the theory, each part of each circuit is analyzed, component by component, until a working knowledge of the entire unit is achieved. Some of the advanced students spent a large part of the year experimenting with the equipment. All of the students expressed interest in the ideas presented.

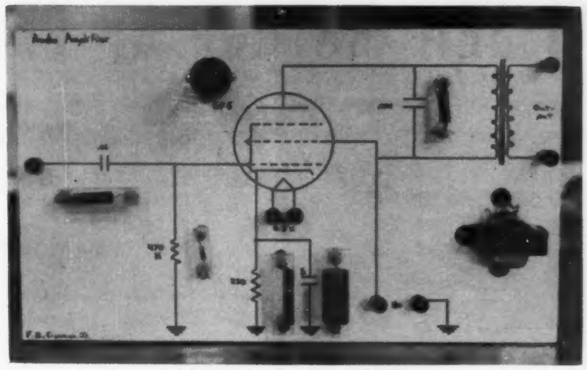


Figure 6. Audio Amplifier

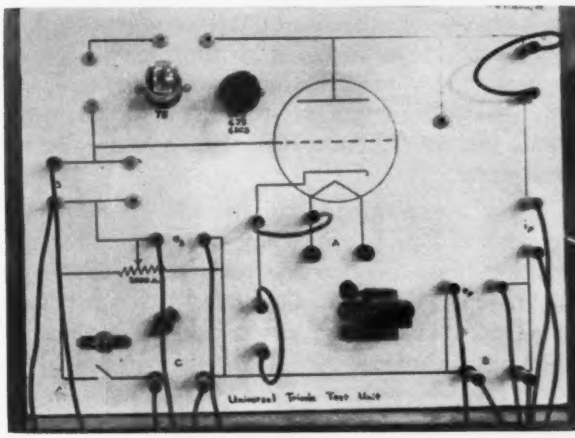


Figure 7. Triode Test Panel

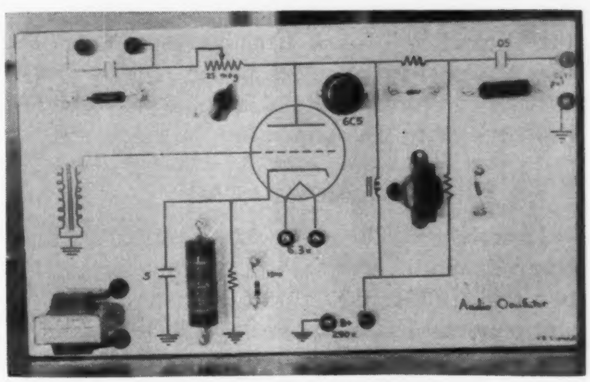


Figure 8. Audio Oscillator

References

1. Philco AN/GSQ-T1, Part No. 453-5132-1, Lecture Demonstration Unit, Philco Techrep Division, Philadelphia, Pa.
2. Welch No. 2620A, AC-DC Broadcast Band Receiver, W. M. Welch Scientific Co., Chicago, Ill.
3. Stansi No. 4806, AC-DC Broadcast Band Superheterodyne Recevier, Stansi Scientific Co., Chicago, Ill.
4. *Basic Electronics,* by Van Valkenburgh, Nooger and Neville, Inc., John F. Rider Publisher, Inc., New York, 1955
5. *Experimental Electronics,* by Muller, Garman, and Droz, Prentice-Hall, Inc., New York, 1942
6. Welch No. 2621, Demonstration Radio Transmitter, *Op. Cit.*

A NEW METHOD OF PRESENTING THE GAS LAWS

By RAY A. WOODRIFF

Professor, Department of Chemistry, Montana State College, Bozeman

and MARJORY GOERING

Graduate Student, Department of Chemistry, Montana State College

THE HISTORICAL APPROACH to the gas laws generally has served its purpose of teaching these laws to high school students but its complexities have often made it an arduous learning task. The following new approach was developed to make the gas laws more understandable to high school students and give them a better background for college work.

After a preliminary comparison of gases with solids and liquids, one comes to the quantitative relationships. If one asks the students what must be known to determine how much gas is in a tank, they will undoubtedly answer: pressure, temperature, and volume.

The next step is the establishing of a mathematical relationship between the gas in the tank and these three factors. The quantity of gas can best be expressed in moles. After deciding this, the student will know from previous experience that the number of moles in the tank is proportional to the pressure and volume and inversely proportional to the temperature.

Questions to Ask

In arriving at these answers, the students might be prompted by being asked these questions: Will two tanks under the same conditions of pressure and temperature hold more than one tank? Will a tire inflated to twice its original pressure, contain twice as much air as before? Will tires filled in the cool of the morning and run until warm—need to have air added or removed to keep the pressure constant?

To account for the units used to measure pressure, temperature, and volume, a constant can be used to convert a proportionality to an equality.

A convenient unit for the measurement of pressure is millimeters of mercury; of volume, liters; and of temperature, degrees absolute.

For these units the constant can be evaluated by experimentally measuring a volume occupied by a given number of moles at a specified temperature and pressure. This has been done many times, and it is found that one mole occupies a volume of 22.4 liters at 273° absolute temperature (T_A) and 760 mm pressure (one atmosphere). Substituting these values in the above expression, the constant becomes .016, and thus the number of moles = $\frac{.016\,(P)(V)}{T_A}$.

In any equality or proportionality, all units must start at zero of the quantity measured. For this reason the ordinary tire gauge or ordinary centrigrade scale cannot be used. In the case of the tire gauge, when it reads zero the tire is still under ordinary atmospheric pressure. The air in the tire is pressing out on the walls at the same amount as the air is pressing in, which is about 15 pounds per square inch. Thus the inadequacy of this scale can be demonstrated by the fact that if the pressure in a tire as shown on the tire gauge is changed from 15 to 30 pounds, the pressure is not twice as great as it was before. This is so because the pressure has actually been changed from 30 to 45 pounds actual pressure. In the centigrade thermometer absolute zero is $-273°$, so this amount must be added to the thermometer reading to get a scale that starts at zero.

The Constant Moles

In a limited number of problems involving the gas laws, the number of moles of gas does not change and we are concerned only with pressure, volume, and temperature. When this is the case, the number of moles before the change is given by $\frac{.016\ P_1\ V_1}{T_1}$ and the number of moles after the change is $\frac{.016\ P_2\ V_2}{T_2}$. Thus, as long as the number of moles does not change

$$\frac{P_1\ V_1}{T_1} = \frac{P_2\ V_2}{T_2}.$$

In physical chemistry, consideration of energy is often more important than the number of moles. Under these conditions it is desirable to solve a gas law equation for PV.

$PV = N\left(\frac{1}{.016}\right)(T)$ where N stands for the number of moles. Most physical chemistry students never really understand this equation. But when derived as above, it expresses the behavior of gases in a way even freshmen can readily understand.

In the historical approach the final volume is ordinarily obtained by correcting the original volume for pressure changes according to Boyle's law and then correcting it for temperature changes according to Charles' law. This approach does not call attention to the necessity for the number of moles remaining constant.

After a fair comparison in actual teaching of the two approaches, we feel that the students make many more errors, even in problems dealing only with changes in pressure, volume, and temperature, by the historical method than by the new one.

Also, in general chemistry it is very important for the student to become accustomed to dealing with moles since this is a fundamental unit of chemical behavior. The number of moles can also be calculated from weight divided by molecular weight, number of equivalents, freezing point depression, liters times molarity, etc. Most of the quantitative calculations of first and second year chemistry involve combinations of these.

This approach to the gas laws requires no new knowledge on the part of the average student, but is merely the reorganization of his knowledge into a more precise mathematical form. This training in setting up and using a mathematical expression is very desirable.

NSTA LIFE MEMBERS

The NSTA Life Member roster is now well over the 200 mark. A record 48 names have been added to the roster since the last listing in the May 1956 issue of *TST,* making a total of 245 as of November 19, 1956. E. Louise Lyons, NSTA's Membership Secretary, a Life Member herself, has made a continuing increase in this roster one of her pet projects. The advantages of Life Membership are many, including a number of special services. In addition, Life Members, with the prestige of this rank, are Special Ambassadors for the science teaching profession.

Following are the 48 new Life Members:

Bailey, C. Sandra, Bakersfield, California
Bollinger, W. V., Pomona, California
Carlson, Edward E., Richland, Washington
Costa, Robert R., Youngstown, Ohio
Craig, Gerald S., New York, New York
Crossfield, A. J., Sacramento, California
Dorrington, Jesse A., San Marcos, Texas
Ellis, Frank W., New Castle, Delaware
Elmer, Lloyd, Edgewood, Maryland
Erwin, Bernard J., Cherry Valley, New York
Evans, D. C., Okmulgee, Oklahoma
Flahive, Daniel J., Schenectady, New York
Gifford, Robert W., Towson, Maryland
Graf, Otto W., Jr., Newark, California
Hjalmarson, Gordon R., Huntington Beach, California
Hupp, Wilfred H., New Holland, Ohio
Jacobson, Willard, New York, New York
Kent, Virginia, Seattle, Washington
Lankowski, Edmund F., New Haven, Connecticut
Lathinen, Lynne, Yuma, Arizona
Lener, Walter, Geneseo, New York
Lungstrom, Richard A., North Sacramento, California
Lytle, T. Fenner, Pennsburg, Pennsylvania
Mason, Clarence, Huntington Beach, California
McCarthy, Eugene E., Chester, Connecticut
Milton, Carl W., Spokane, Washington
Morgan, K. C., College Station, Texas
Nesbitt, William O., Hillsboro, Texas
Nixon, Alfred, Washington, D. C.
Pederson, A. Robert, Fargo, North Dakota
Perdew, George M., Agana, Guam
Pinard, Mrs. Donald, Olympia, Washington
Poorman, Lawrence E., Columbus, Indiana
Pratt, Leonard H., Center, Colorado
Pregger, Fred T., Trenton, New Jersey
Raskin, Abraham, New York, New York
Richter, Don, San Francisco, California
Savage, Richard P., Stillwater, Oklahoma
Schneider, Benoit R., Waterville, Ohio
Sherman, Robert C., Denton, Texas
Sipe, H. Craig, Helena, Alabama
Stedje, Raynard L., Zumbrota, Minnesota
Stevens, George H., Candor, New York
Sutman, Frank X., Paterson, New Jersey
Warneking, Glenn, Silver Spring, Maryland
Watts, Lawrence M., Denver, Colorado
Wilhite, John R., Ste. Genevieve, Missouri
Wozny, John, Long Beach, California

REPORT OF THE NEW YORK CITY ADVISORY COMMITTEE ON SCIENCE MANPOWER

(Editor's Note: The following article is a summary from the report made in October to Dr. William Jansen, New York City Superintendent of Schools. The Advisory Committee on Science Manpower was appointed a year ago by Dr. Charles H. Silver, President of the New York City Board of Education, and Dr. Jansen, to recommend measures which could be used by schools to overcome shortages in scientific manpower facing education and industry. Dr. John R. Dunning, Dean of the School of Engineering, Columbia University, New York City, served as chairman of the committee, and Samuel Schenberg, Supervisor of Science, New York City Board of Education, was named executive secretary.)

THE SCIENTIFIC MANPOWER SHORTAGE has many facets and this committee attacked them along two broad lines. In the first place, the committee, through the recommendations which follow, attempted to provide a suitable climate which would attract gifted and average college-bound students into the science and mathematics departments in our high schools with the expectation that careful selection, thorough preparation, and good guidance would provide the necessary stimulation for an adequate number of them to specialize in the scientific, engineering, and the science and mathematics teaching professions. In the second place, the committee attempted to provide a suitable climate which would attract science teachers and would enable them to grow professionally and be contented and respected in their chosen profession.

The committee recognized the fact that an adequate salary was one of the most important factors contributing to a suitable environment and it must reflect general economic conditions as well as the status, preparation, and professional competence of the teachers.

The recommendations have been divided into two parts. Part I contains 15 recommendations which, in the judgment of the committee, are crucial and call for immediate action by the Superintendent of Schools. Part II also contains 15 recommendations some of which, in the opinion of the committee, although important, are not crucial at this time. Other recommendations are long range in nature and should be started as soon as possible. All recommendations in Part II are submitted to the Superintendent of Schools for implementation after the completion of Part I.

PART I

A. Recommendations designed to increase the supply of secondary school science, mathematics, and engineering teachers and to utilize the present staff more effectively

1. Postpone pre-service education course requirements for a science and mathematics substitute's license to enable the immediate employment of college graduates.
   a. Require each substitute to take a minimum of six semester hours in approved courses each year to qualify for the annual renewal of his substitute's license.
   b. Permit the substitute to become eligible to take the examination for a regular teacher upon the completion of 24 semester hours in approved courses.

2. Encourage qualified and interested elementary school teachers to take examinations to teach science and mathematics in the junior and senior high schools.

3. Add an additional period of science or mathematics where necessary to the program of a highly qualified teacher and compensate him.

B. Recommendations designed to improve the effectiveness of science teachers in the classroom and to raise their morale

4. Provide more laboratory assistants for assignment to senior and junior high schools.

5. Better supervision of science teaching at all levels. More time for supervision should be permitted each chairman to take care of the increased load.

6. All Board of Education in-service training should be carefully planned, subsidized, and supervised. Supervisors and competent teachers giving these courses should be compensated. A special fund should be established for this purpose.

7. Provide summer employment for science and mathematics teachers and for interested students through the cooperation of industry.

8. Provide television reception for all schools and provide model lessons in science as useful in-service training.

9. Improve and extend the science program in the elementary schools.

10. Improve and extend the science program in the junior high schools.

C. Recommendations designed to encourage all students in high school to study more science and to guide those students who are capable and interested toward careers in science

11. A comprehensive and intensive guidance program should be introduced by the Division of Guidance to assist students and teachers. Pamphlets prepared for distribution to students should be written in a language that students can understand. Make available to students and teachers science and engineering career booklets provided by scientific and engineering societies, Manufacturing Chemists' Association, National Association of Manufacturers, and many industries.

12. Require all academic students to take a minimum of two years of science in grades 10, 11, and 12. One of these should be a physical science.

13. Raise the units required for graduation from 18 to 19 units to avoid conflicts with other subject areas.

14. Introduce an "Academic Diploma Science Major" which will call for four years of science and a minimum of three years of mathematics.

15. Encourage pupil's interest in science and mathematics through appropriate, challenging, and satisfying activities.

a. Encourage participation in fairs, career conferences, junior scientific societies, and science project scholarship contests.

b. Provide lectures on timely subjects in science and technology to groups of high school students in a high school auditorium. The lecturers should be selected carefully on the basis of their past experience and ability to interest students. A series of eight should be planned.

c. Provide trips to industries, scientific laboratories, and museums.

PART II

A. Recommendations designed to increase the supply of secondary school science, mathematics, and engineering teachers and to utilize the present staff more effectively

1. Encourage married women to return to teaching on a part-time basis if necessary.

2. Permit and encourage retired teachers, scientists, engineers, and qualified people in business and industry to teach on a part-time basis.

3. Recommend the inclusion of education and methods courses for qualified personnel in the armed services to interest, stimulate, and guide enlisted personnel for the teaching profession.

4. Provide auxiliary personnel in the schools to eliminate the supervision of the lunchroom, study halls, and the corridors by teachers, thus providing them with an extra period for consultation with students and other classwork duties.

5. Appoint, assign, and transfer qualified science teachers to schools where their special training and skills will be utilized to the full.

B. Recommendations designed to improve the effectiveness of science teachers in the classroom and to raise their morale

6. A handbook on science teaching should be available for each new teacher. It should include materials on methodology, facilities, in-service training, and orientation with the Board of Education and the State Education Department.

7. A science consultant should be assigned to the office of each field assistant superintendent.

8. Provide science supervisory positions for the elementary and junior high schools. Make science teachers in all divisions eligible.

9. Encourage science teachers to keep professionally alert to advances being made in their field of specialization and in the field of education.

10. All laboratory work should have two periods, minimum 80 minutes; more experience on an individual basis is required.

11. Keep class registers down to 32.

12. Science rooms, where possible, should become the rooms of individual teachers. There should be incentive for the teachers to maintain a science atmosphere through the use of charts, exhibits, and other scientific displays.

C. Recommendations designed to encourage all students in high school to study more science and to guide those students who are capable and interested toward careers in science.

13. Require all General and Commercial students to take a minimum of one year of science in the 10th, 11th, or 12th year. Add an additional general science course, with adequate emphasis on physical science in the 10th year.

14. Provide adequate scholarships in college to permit gifted students to remain in school and devote their full time toward specialization in the fields of science and mathematics.

15. Science talent must be identified as early as possible. Adequate records should be kept of science talented pupils in the elementary, junior high, and senior high schools.

Animals in the Science Classroom

By JOHN D. WOOLEVER

Sarasota, Florida, Senior High School

PERIODICALLY there is public discussion, either by word or in print, of inhumane treatment of animals. When this debate flares up, invariably the science classroom is brought into it. The accusation is made that even younger children are taught to feed and generally treat laboratory animals in a cruel and indifferent manner.

It seems reasonable to conclude that the feeding argument stems from the once well-known group of nutrition experiments included in outdated general science and biology textbooks. Originally these experiments were suggested when laboratory demonstrations and experiments were just starting to enter the field of science education. It was proposed that teachers repeat nutrition experiments to show what improper diet could do to a person. Children were enlisted to aid in the care of these animals to give them an opportunity to participate. The experiments also encouraged good eating habits at a time when the importance of vitamins and minerals was being fully realized and receiving public notice. The main purpose of the experiments was to have the children learn things firsthand with common, available materials rather than just listen to or read about scientific accomplishments. Now, however, it is very difficult to find a text or manual printed in the last 15 years that outlines or even suggests these particular nutrition experiments.

The gradual disappearance of these experiments in the classroom was not meant to discourage experiments nor was it a step toward anti-vivisection. Quite the contrary. It was a step in the direction of better methods, more materials, and better facilities in the science room which are still being fought for today. Students have more opportunities. Teachers are better trained. Objectives have been clarified. Science teachers who use outmoded methods or antiquated texts are merely the product of the school systems that employ and tolerate them. They have only themselves, not the teachers, to blame for any laboratory improprieties.

Except in very rare cases, children are naturally inclined to be interested in animals and to treat them kindly. A teacher can usually recognize any child that has an abnormal feeling toward animals. It is part of the science teacher's job to keep animals in the room and teach children kindness and humane treatment of their pets. There is no question whether actually seeing the results of vitamin deficiencies in animals is of any real value to the student. Sufficient work has been done in the field with accompanying photographs, charts, and graphs. Most textbooks include these visual aids. To reproduce the conditions that are shown in these photographs was found to be time-consuming, expensive, and relatively complicated. There are now thousands of other experimental science activities that do a better job. That is why nutrition experiments have been discarded.

The children still experiment and work with animals more than ever and a great deal is gained merely by changing the nature of the experiments. In fact, valuable contributions are being made, especially in comparative psychology. With a little ingenuity on the part of the teacher, dozens of simple harmless experiments are performed with animals that benefit the students and do no harm to the animals.

Modern manuals and texts which include animal experiments never suggest the use of a child's pet. Children are the first to object to anything that hints of cruelty to animals. When science fair projects are in the making, teachers discourage poorly-planned "senseless" experiments and see to it that students use proper and humane methods even if the animals are merely for display purposes. Examination of projects submitted to any fair will demonstrate the small number involving live animals. Textbook authors have practically eliminated experiments that produce questionable benefits as there are too many other experiments children can perform.

The humane treatment of laboratory animals is neither new nor local. The Animal Welfare Institute (not anti-vivisectionist) recently awarded the Albert Schweitzer Medal to an individual who made an outstanding contribution to the humane treatment of laboratory animals. The larger meat packing companies are using quicker and less painful methods in their slaughter houses. In England there are many organizations whose members are concerned with the same problem. A great deal of progress is being made.

TEACHING CHEMISTRY THE EASY WAY

By PAUL WESTMEYER

Instructor in Education, University of Illinois, Urbana

EDITOR'S NOTE: *Chemistry and other science teachers may wish to compare Author Westmeyer's ideas on teaching chemistry with the report of the Marathon Fellows on the same subject. Titled* High School Chemistry: Keeping the Course Up to Date, *it is a special insert in this issue, beginning on page 401.*

TO YOUNGSTERS, EVEN OF HIGH SCHOOL AGE, there is something fascinating about "chemicals." There are things that can simply be poured together to result in brilliant colors, dense smoke, spontaneous flaming, or even explosions. Furthermore, for many youngsters, to build some device or perform some experiment of their own devising is a very satisfying experience. Couple these facts with the additional one that most people of high school age are learning to communicate ideas to one another effectively and enjoy practicing this art if they can do it informally. In this combination of facts lies the key to a most pleasant and effortless way to teach high school chemistry.

There must be one word of caution to the teacher. Young people enter into the study of chemistry with natural enthusiasm. The teacher must avoid dulling the edge of that enthusiasm. Instead, it can be sharpened by allowing the student to exercise his curiosity; even, if need be, by arranging for him to have some degree of success in his investigations.

Chemistry, of course, is a highly organized science and it is expected that the high school chemistry course will follow more or less of an organized pattern. This, however, does not mean it must be rigidly organized. There are certain major topics that must be covered, if the course is to serve some students as a prerequisite to college entrance. But there are a great variety of ways of covering these topics. One of these is the "pleasant and effortless" way described herewith.

First of all, it is obvious that, unless the students have already had some training in laboratory techniques, there will have to be some discussion and demonstration of basic rules and procedures. Even here, however, students can be allowed to use some ingenuity. For example, the teacher can demonstrate how to bend glass tubing. Then, instead of requiring certain prescribed bends, he can show the students some equipment they will need in the laboratory in the future and let them make it as best they can. They will make mistakes and have to re-do certain parts but this is all to the good, even though the budget must be watched.

After certain fundamentals of knowledge and technique have been taught and an overview of the course has been given, the class may elect a steering committee which will guide further procedures. However, the class should understand that the teacher still has veto power. They could also elect a content committee, a library committee, a stockroom committee, a clean-up committee, etc. As a matter of fact, the more committees, the less work for the teacher. He becomes more and more a director of research and less and less a taskmaster.

Since the teacher is a member of the steering committee, by his own decree, he can make suggestions as needed. Actually they won't be needed often, for students are capable of almost unbelievable self-direction under proper conditions. The steering committee decides on matters of policy and procedure within the framework of the master plan, which is something like this:

1. A topic is decided upon, the class discusses it, and assignments are made. Perhaps it would be better to speak of the assignments as being accepted rather than made, for the students decide upon them themselves.
2. If reports were a part of the assignment, they are heard and discussed.
3. Certain laboratory work is suggested as a result of the reports and/or assignments. These are discussed by the group. For one thing they must see if they have or can get the needed materials. (Here the stockroom committee functions.) Perhaps some parts of the laboratory work are labeled *required* and others, *optional*.
4. Now the instruction is further individualized. A pre-test is given on the material studied. Those whose information or application is not too good, meet with the teacher for more detailed study and explanation. Meanwhile, those who pass the pre-test, work in the laboratory. They are expected to do more of the optional work than those who have less laboratory time.

(Please continue on page 429.)

The ABC'S of Bacteriology

By MARTHA R. SHEEK

Department of Bacteriology, University of Illinois, Urbana

LESS than 300 years ago, Antony van Leeuwenhoek, a Dutch janitor–lens maker, first peered into the fascinating world of "wee beasts" and established their ubiquity in nature. But he attached little significance to their existence. Within the past 70 to 80 years, some other men, including Louis Pasteur, Robert Koch, and Alexander Fleming, have delved into the activities of these curious wee beasts of the microscopic world and have evolved the concepts underlying fermentation, disease, and lifesaving antibiotics. These men opened a new world of knowledge and human happiness.

Hundreds of others—discoverers of sera, of vaccines, of viruses; students of fermentation; probers of sunlight-trapping pigments; chemists of proteins—have poured over microbes to understand them, control them, prevent their harmful effects, and harness their wonderful powers. These are the men and women called bacteriologists.

Our world literally lives and dies by the microbes. All life on earth depends on the activities of these infinitely small, infinitely active organisms which, unseen to the naked eye, populate soil and water. The nitrogen of the air, the iron of the streams, the sulfur of the volcanic springs, and many other elements are made available to the living world by these indefatigable toilers, the bacteria. The dead matter from plants and animals is released and made pure and useful again by bacteria. The preservation of foods by the traditional means of primitive peoples and by modern industrial processes depends on activities of bacteria. And the life of man, supported and made possible by this world of microbes, is in turn endangered by the activities of some members of the microbial world.

The activities of microbes are the subject matter of bacteriology. Understanding and control of the microbial world are its goals. Diagnosis, treatment, and prevention of disease; harnessing of fermentations to produce useful chemicals; control of spoilage of foods and water supplies; production of new foods; preparation of textile fibers; even protection of our artistic and historical treasures—these are the tasks of bacteriologists working for human welfare.

But apart from its practical achievements, bacteriology has much to contribute in the field of pure science. The understanding of the chemistry and the physics of life, the achievement of an integrated picture of life as a part of natural science, require a study of life at its simplest. Bacteria, only a millionth of an inch in size, manifest all basic properties of life and yet are simple enough to reveal the play of physical and chemical phenomena unobscured by the many complexities of larger organisms. Viruses give us an insight into the transition between molecules and living organisms and make the chemistry of life a reality for study instead of an empty phrase.

Bacteriology as a Career

The student who has obtained a Bachelor's degree in bacteriology has a varied choice of careers. He or she can find employment in pharmaceutical industries, food industries, and many others. Careers are open both in production and in research; industrial research in microbiology is carried out by hundreds of companies, with large, well-equipped laboratories. The young bacteriologist can work in hospitals and medical laboratories, either as a laboratory diagnostician or in research. And, the federal, state, and city governments offer a variety of civil service opportunities to the trained bacteriologist.

If a graduate wishes to continue his education to the Master's degree or the Doctor of Philosophy in bacteriology, more careers are open including university and college teaching. Scholarships, fellowships, and assistantships from a variety of sources are generally available to the superior student who wishes to work for an advanced degree.

To students who major in other fields, courses in bacteriology provide a view into a fascinating field of knowledge. For an understanding of our modern world, with its technological complexities and interdependencies, microbiology opens valuable perspectives. The place of microbes in the living world; the impact of epidemiology and sanitation on modern life; the role of microbes in the chemistry of natural products—these are some of the facts that the thoughtful student will encounter in bacteriology.

THE SCIENCE TEACHING IMPROVEMENT PROGRAM

of the American Association for the Advancement of Science

By I. E. WALLEN

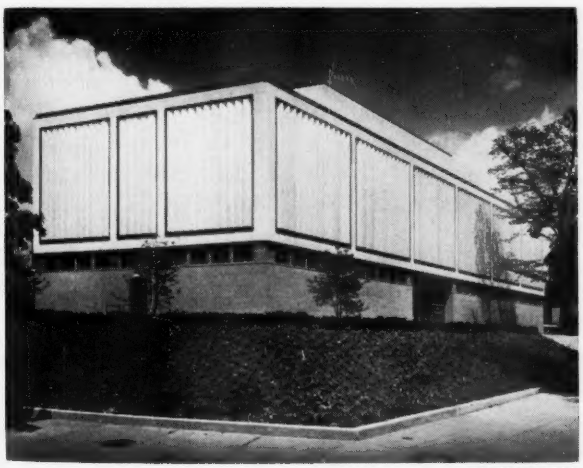
Assistant Director, STIP

THE SCIENCE TEACHING IMPROVEMENT PROGRAM (STIP) came into being in July 1955, when the Carnegie Corporation granted funds for the project to the American Association for the Advancement of Science (AAAS). The program was developed jointly by the Cooperative Committee on the Teaching of Science and Mathematics and a Committee of the Academy Conference, the central group of state and city science academies.

On September 12, 1955, Dr. John R. Mayor, Acting Associate Dean of Education and Professor of Mathematics at the University of Wisconsin, came to Washington, D. C. to direct the program. On January 25, 1956, he was joined by the writer, who was Associate Professor of Zoology and Chairman of Biological Science Courses at the Oklahoma Agricultural and Mechanical College.

STIP was planned with two major objectives: to contribute to the improvement of science and mathematics teaching at the secondary school level, and to increase the number of well-qualified science and mathematics teachers. The action program includes proposals in seven related areas, as follows:

(1) Assistance to college and university Science and Mathematics Departments in their acceptance of teacher education as a major responsibility



DAVIS STUDIO

The new, modern headquarters of the AAAS in Washington, located on Massachusetts Avenue, is already one of the capital city's architectural landmarks.

(2) Work with colleges of education in the development of special training programs in teacher certification

(3) The recruitment of students interested in the study of science and mathematics and in teaching

(4) The improvement of salaries of teachers

(5) The improvement of working conditions for teachers

(6) The giving of "Distinguished Teacher" awards to secondary school science and mathematics teachers

(7) A pilot study on the use of Science Counselors

Among the activities considered appropriate to the study has been the collection of data that could be of use in definition of the problems and their solution. Data that revealed trends toward increase in enrollments in science and mathematics were gathered during the first year of operation. Since the U. S. Office of Education is gathering enrollments data during 1956-57, this study will not be repeated.

Preliminary data on the kind of effort that colleges, through their teacher preparation programs, were making to recognize and meet certification problems was gathered in 1956. Supplementary data on the nature of offerings and requirements for teacher certification will be requested during 1956-57.

By cooperating in U. S. Office of Education studies and by giving direct assistance anywhere this seems desirable, STIP is hoping to secure detailed information concerning the status and qualifications of secondary school science and mathematics teachers. This information should be prepared on a state-by-state basis in order that scientists may make specific suggestions on improvement of certification practices. Scientists are being asked to concern themselves with specific requirements for certification in order to provide them with a better understanding of the problems as well as to enable the opinion of science and mathematics groups to be heard in the channels where decisions are made.

During the first year of operation, representatives of STIP have presented the program to

scientists on 39 college and university campuses, in state and regional meetings called by STIP, at meetings of 11 state academies of science, and to many professional scientific societies. At these meetings many good suggestions were obtained, counsel was given on the development of projects, and cooperation sought in the attainment of STIP objectives. This kind of activity is being continued with plans under consideration for the use of regional STIP representatives in order to better serve the scientists, upon whose efforts the success of the program rests.

Opportunities to cooperate with the U. S. Office of Education and the National Educational Association (NEA) have been often provided. The goals of STIP have been presented at national meetings of education organizations. One of the most promising of the cooperative activities of scientists and educators is with the American Association of Colleges for Teacher Education (AACTE). As a beginning, this cooperation resulted in the establishment of the Joint Commission on Science Teacher Education, sponsored by AACTE and AAAS. The National Science Teachers Association has liaison membership in the Joint Commission, which is in the process of developing a major study of new and better ways of training science teachers.

In attempts to become familiar with activities in science education on a national basis, STIP has advised, through correspondence, a multitude of persons planning programs in science education. STIP personnel have asked for help from and assisted many scientific societies and other agencies in the development of programs to improve science education. Responsibility for a semi-annual newsletter about the science education activities of the various societies has been assumed by STIP as an outgrowth of a conference sponsored by AAAS and the National Science Foundation.

Information is being gathered concerning the possibility of becoming directly involved in studies of motivation. Projects directed toward the determination of the effectiveness of career pamphlets, film and television programs, personal contacts, and other approaches to recruitment are being considered by a STIP panel as a prelude to increased activity in this area. The AAAS is also cooperating with the Educational Advisory Board of the National Academy of Sciences/National Research Council in a review of the use of television in science teaching.

A considerable volume of data has been distributed to scientists to aid them in calling attention to the needs of secondary school teachers for better salaries and working conditions. Many discussions have been held by STIP, both with personnel of NEA and education authorities met during various travels, on ways to improve the status of the teacher. STIP personnel have offered to cooperate with any agencies interested in a special study of merit salary increases as well as with the Atomic Energy Commission in the development of programs to supply laboratory equipment to the secondary schools.

Awards for Master Teachers

Funds are being sought for a program of awards to "Master Teachers." It is hoped that 100 awards can be given per year to science and mathematics teachers throughout the country. These awards should include a cash gift as well as a trip to a national meeting where the teacher could receive further recognition for excellence.

STIP's pilot Study on the Use of Science Counselors is based on a recognition of the valuable service that can be provided to teachers by competent supervisors and counselors. A good counselor should stimulate and guide the work of a group of well-prepared and less-experienced teachers. Since counseling lies in the rather intangible middle of relationships with universities and state departments of education, the study was organized with university and state department cooperation as an initiating premise.

The Universities of Texas, Oregon, and Nebraska, and the Pennsylvania State University have accepted grants and hired two counselors who are working with schools selected from among those requesting this service. It is hoped that basic information concerning the ability of counselors to bridge the gap between high school and college science and mathematics courses will be obtained. Some information on the number of teachers that can be effectively served and the most desirable types of services that universities may provide to the secondary schools should be forthcoming.

The study should be effective by improving the science and mathematics instruction in those secondary schools served. It should provide the teacher with assistance in choosing course content and methods of laboratory instruction. It should bring about further contact between university and high school personnel to the benefit of both. The study should provide additional career counseling services to the participating schools. It should

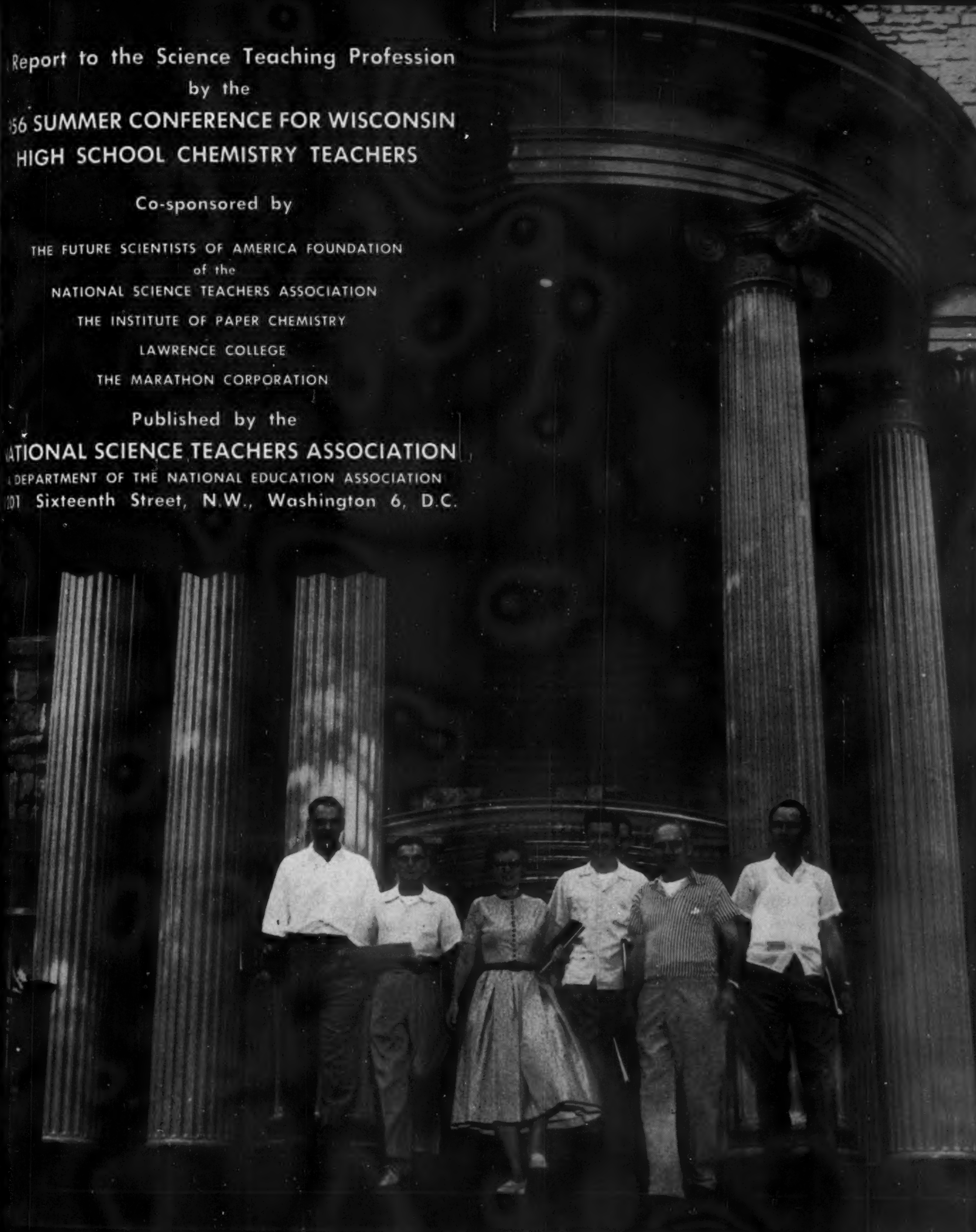
(Please continue on page 430.)

Report to the Science Teaching Profession
by the
56 SUMMER CONFERENCE FOR WISCONSIN
HIGH SCHOOL CHEMISTRY TEACHERS

Co-sponsored by

THE FUTURE SCIENTISTS OF AMERICA FOUNDATION
of the
NATIONAL SCIENCE TEACHERS ASSOCIATION
THE INSTITUTE OF PAPER CHEMISTRY
LAWRENCE COLLEGE
THE MARATHON CORPORATION

Published by the
ATIONAL SCIENCE TEACHERS ASSOCIATION
DEPARTMENT OF THE NATIONAL EDUCATION ASSOCIATION
01 Sixteenth Street, N.W., Washington 6, D.C.



HIGH SCHOOL CHEMISTRY . . .
keeping the course up to date

ALBERG, BERNARD L.
Kaukauna High School
Kaukauna, Wisconsin

ALTEMUS, ELAINE
Beaver Dam High School
Beaver Dam, Wisconsin

BAXTER, JOHN F.
Conference Co-director
University of Florida
Gainesville, Florida

BOWMAN, HARRIS A.
West High School
Green Bay, Wisconsin

BROOKE, BYRON
Union High School
Rhinelander, Wisconsin

BRUNNER, VINCENT F.
Shawano Senior High School
Shawano, Wisconsin

BULMER, HAROLD
D. C. Everest High School
Schofield, Wisconsin

BYRUM, STAFFORD D.
Marinette High School
Marinette, Wisconsin

CARLETON, ROBERT H.
Conference Co-director
National Science Teachers Association
Washington, D. C.

CROW, RICHARD A.
Berlin High School
Berlin, Wisconsin

EDIGER, G. A.
Appleton High School
Appleton, Wisconsin

ENGER, CARL A.
North High School
Sheboygan, Wisconsin

REV. RODERICK FENZL, O.PRAEM
St. Norbert High School
West De Pere, Wisconsin

GIFFORD, DOROTHY
Special Conference Consultant
The Lincoln School
Providence, Rhode Island

HANNAN, JOHN
Kimberly High School
Kimberly, Wisconsin

HANSEN, VERNON J.
Lincoln High School
Manitowoc, Wisconsin

HORNIGOLD, A.
Lincoln High School
Wisconsin Rapids, Wisconsin

JOHNSON, HARRY A.
Wausau Senior High School
Wausau, Wisconsin

KARNATH, BRUCE A.
Mosinee High School
Mosinee, Wisconsin

KRUSCHWITZ, MRS. JENNIE C.
Ashland High School
Ashland, Wisconsin

LARSON, ALEX M.
Tomahawk High School
Tomahawk, Wisconsin

LOOS, JOHN C.
West High School
Green Bay, Wisconsin

LUCHSINGER, PERRY O.
Clintonville Public Schools
Clintonville, Wisconsin

MALLMAN, GERALD P.
Fox Valley Lutheran High School
Appleton, Wisconsin

MATTHIAS, HAROLD E.
Ashland High School
Ashland, Wisconsin

McDERMID, JOHN E.
East Side High School
Sturgeon Bay, Wisconsin

McMASTERS, DONALD R.
East High School
Green Bay, Wisconsin

NAHLEY, LYLE WILLIAM
East High School
Green Bay, Wisconsin

O'HERN, JAMES M.
Hortonville Union High School
Hortonville, Wisconsin

PRIBNOW, WALTER C.
Appleton Senior High School
Appleton, Wisconsin

RIDGE, HARVEY J.
Wausau Senior High School
Wausau, Wisconsin

RONE, NORMAN C.
Menomonie High School
Menomonie, Wisconsin

SCHULTZ, E. W.
High School
Oshkosh, Wisconsin

SCHNEIDER, E. J.
High School
Oshkosh, Wisconsin

SPAULDING, RICHARD R.
Kimberly High School
Kimberly, Wisconsin

STENZEL, ERWIN J.
P. J. Jacobs High School
Stevens Point, Wisconsin

TYLER, WILLIAM A.
Washington High School
New London, Wisconsin

WENTZEL, ROY
Brillion High School
Brillion, Wisconsin

WOLK, ROBERT H.
Seymour Union High School
Seymour, Wisconsin

FOURTH ROW—Nahley, Larson, Tyler, Crow, Brooke, Karnath, Brunner, Kruschwitz, Lewis (Dr. Harry F. Lewis, Vice-President, The Institute of Paper Chemistry)

THIRD ROW—Alberg, Mallman, Wolk, Matthias, Schultz, Schneider, Kieffer (Dr. William A. Kieffer, The College of Wooster, Ohio, visiting lecturer), Spaulding, Hannan, Hansen, Carleton

SECOND ROW—McDermid, Bulmer, Fenzl, Luchsinger, Rone, Enger, Johnson, Ediger, Ridge, Altemus, Baxter

FRONT ROW—Byrum, Wentzel, Hornigold, Bowman, McMasters, Loos, Stenzel, Pribnow, O'Hern, Gifford

MARATHON FELLOWS

HIGH SCHOOL CHEMISTRY . . .
keeping the course up to date

This report from 36 high school chemistry teachers (see our picture on the opposite page) was written for the most part in the full blush of enthusiasm generated during a two-week conference held August 20-31, 1956, at Lawrence College and the Institute of Paper Chemistry in Appleton, Wisconsin. As we sang at the conference banquet (tune: "I've Been Working on the Railroad"),

"We are the Marathon Fellows,
The mental fog is blowing away.
Nuclear energy and pH,
Molecules and oxidation are here to stay."

We *were* enthused. We think we were a fairly representative group of high school chemistry teachers—teaching experience ranged from two years to 37 years; "hours in college chemistry" ranged from ten undergraduate to 32 at graduate level; only five of us had ever been in any previous summer conference or institute of this kind. Our ideas about how to teach high school chemistry probably ranged from conservative toward "progressive" in about the same degree as most samplings of teachers would provide. Confidence that we were a fairly good "across the board" sample stems from the simple fact that we were not selected from a hundred or more applicants for Marathon Fellowships. Rather, we were selected, so we understand, simply because we happened to be the chemistry teachers in the high schools located within a limited geographic region.

For the purpose of reporting our conference to chemistry teachers who read *The Science Teacher*, we divided into three committees. Two of these committees considered the problems of the teacher in keeping up to date with the advance of chemical knowledge and in methods of teaching. The third committee considered problems associated with making the laboratory and laboratory-type activities effective in the teaching of high school chemistry. Our report is divided into these three sections. It is now yours to read. We hope it will be helpful in one way or another. Anyway, won't you let us hear from you? We'd like to know whether we have hit some important targets.

ON THE COVER

A spirit of friendship and conviviality marked the Marathon Conference as can be seen in this photograph of a group of the Fellows descending the steps of Brokaw Hall, their living quarters. This photograph and the others which illustrate this report were provided through the courtesy of the Marathon Corporation.

SECTION I

Knowledge and Selection of Subject Matter

The tremendous growth in chemical knowledge and its applications in recent years creates a problem for all teachers of high school chemistry. Continual modification of the chemistry course by the process of addition only is obviously impossible. Present textbooks (for reasons readily understandable) contain much more factual material than can be assimilated with any semblance of permanency by students in a one-year high school chemistry course. There are, however, certain basic laws, theories, and principles, a functional understanding of which all students should seek to develop. Development of control over these "fundamentals" and ability to use them in explaining and predicting phenomena should be major goals of instruction in high school chemistry. The factual material of texts and references is useful *as a means* of developing these understandings. It seems, then, that chemistry teachers must continually and carefully examine the subject matter content of their courses with judicious revision in view.

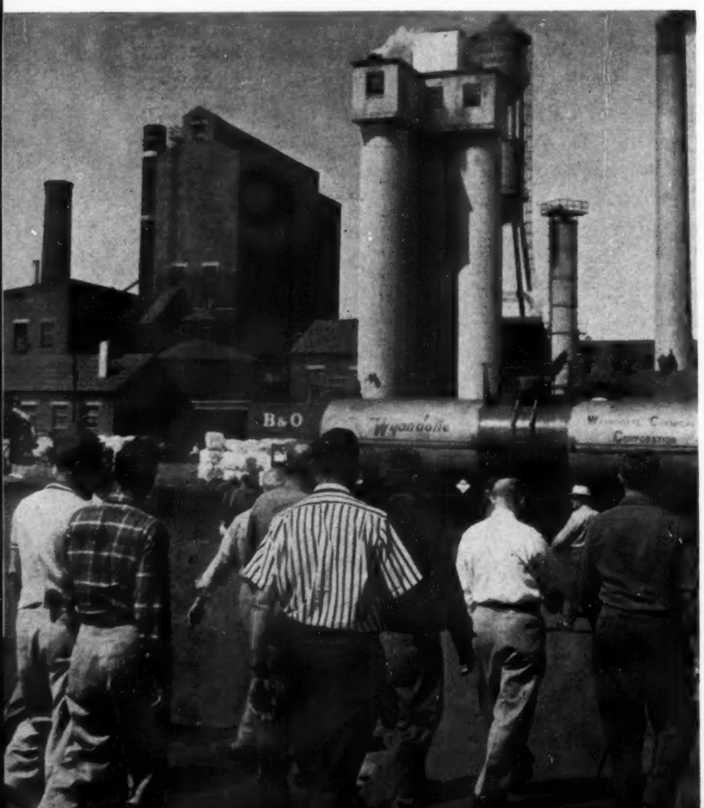
The above point of view clearly implies a considerable departure from conventional ways of evaluating student progress and achievement. This aspect of chemistry teaching, however, is not pur-

sued in this report. Suffice it to say that the "Name three allotropic forms of sulfur" kind of question will not in the slightest degree reveal the accomplishments of students in developing understandings of and ability to use "the fundamentals"—to say nothing of reaching the important goal of "ability to use the methods of scientific thinking and inquiry."

We realize that it would be impossible to find complete, detailed agreement among any group of subject-area teachers on the skeleton or fundamentals of their course. However, the conference committee working on the subject-matter content of high school chemistry attempted to identify those topics without which they felt no chemistry course would be complete.

We believe that the essentials of a high school chemistry course—whether approached inductively or deductively, through "problem situations," or by more traditional procedures—should include a basic principle. This is careful consideration of the structure, properties, and chemical reactions of common and representative elements and their compounds. Therefore, we believe it is highly desirable that the students acquire a working knowledge of theories of the structure of matter early in the course. A problem for the teacher to identify and work out is how much background knowledge and experience the students have on which to build these theories. If meager, our estimate is that it

The Fellows visit Marathon's Rothschild operations to observe the paper industry's application of chemistry and other sciences.



can be provided within three to four weeks at the beginning of the course.

We recommend a selection of subject matter topics which includes the following:

1. A study of the nature of matter and energy and the properties of each which are useful to the chemist
2. A more detailed study of a few, representative common elements and compounds which act as metals, nonmetals, acids, or salts
3. A study of the structure of matter involving the notions of molecules, atoms, electrons, neutrons, protons, and ions
4. A study of the periodic arrangement of the elements (long form) and its use in predicting chemical behavior
5. A study of chemical reactions in solution such as neutralization, hydrolysis, and equilibrium; also, how to write equations for these reactions in agreement with the law of conservation of mass
6. A study of simple chemical calculations such as percentage composition, formula weights, weight to weight, and simple gas problems
7. A study of simple organic compounds which illustrate the different structural arrangements of the covalent carbon atom
8. A study of nuclear energy as it relates to radioactivity, radioisotopes, and possible future uses of the energy released by fission and fusion
9. A study of the basic principles of metallurgy, supported by more detailed attention to only a few (perhaps two to four) of the individual metals

Other topics may, or should be, added to the above core subject areas. These additions may be of historical significance or of industrial, domestic, social, economic, regional, or individual application which will give the course continuity and coherence, and which will stimulate pupils to investigate, experiment, or explore problems or projects of a chemical nature.

We believe an effective high school chemistry course should also provide precise information and experiences for students regarding the methods used to study science problems, the methods used to get information, and the methods used in handling the tools of the scientist. In fact, for

At the Rothschild laboratories, plant manager Charley Wagner gives the Fellows a review of operations.

many teachers, a problem approach in which methods of inquiry are stressed will be the means through which understanding and mastery of "subject matter" will be achieved.

We believe that the course content should be treated so that it will encourage the development of a meaningful chemical vocabulary. This, in turn, will enable the student to develop accurate concepts which he may expand as his abilities, interest, and next-step aims indicate. At the same time, we caution that overemphasis on vocabulary study, *per se,* can be a deadly, interest-killing activity.

If the high school chemistry course is to be kept up to date, it seems obvious that the first requirement is that the teacher be up to date in his knowledge of chemistry and its applications. We recommend particularly that teachers try to keep up with developing ideas and some of the more recent theories in such areas as ionization, valence, oxidation-reduction, structure of solids, and acid-base behavior in aqueous solutions. The teacher need not include a full treatment of these theories in the course syllabus. But the teacher should possess sufficient background in them to be able to use them in working with the entire range of students' abilities met in the average classroom. Many of the students are stimulated by contact with recent theoretical explanations. Also, it is desirable that students realize the vastness of what we do not know and that they should remain curious, observant, and open-minded to the end.

How can the teacher keep up to date? Most teachers are not in a position to "go back to school" every summer or so, much as they would like to do so. On the job, teachers must prepare for, and meet, a full schedule of classes, often in two, three, or more fields. In addition, they are assigned an ever-increasing load of extracurricular duties which demand more and more time. Realizing this, we present the following as ways by which a teacher may, with economical use of valuable time, attempt to keep abreast of the rapidly moving field of chemistry.

1. **Reading and study of new textbooks.** Maintain a reference library of the latest editions of chemistry texts on both the high school and college level. Textbooks for college freshman chemistry would seem to represent the mimimum level of literacy in this field for high school teachers of the subject.

2. **Subscriptions to science magazines.** The school or the chemistry teacher should regularly receive all of these journals: *Scientific American, The Science Teacher, Journal of Chemical Education, Scientific Monthly,* and *Chemical and Engineering News.* Many of the chemical companies publish magazines which are useful to both teachers and students, and these are commonly sent free to teachers on request.

3. **Use of business-sponsored teaching aids.** Hundreds of items are available in the form of charts, kits, pamphlets, films, and filmstrips. The NSTA Packet Service is an invaluable aid in bringing such items to teachers and their students.

4. **Conferences, meetings, or workshops.** High school chemistry teachers should meet frequently with college and industrial chemists. Much can be done on a purely informal basis. In one instance, a college professor is donating his time to meet with all interested chemistry teachers within the county. Seminar sessions to review current ideas in chemistry are scheduled for three-hour periods one night a week for one semester. There is "no cost, no credit." A somewhat similar plan sponsored by industry has been operating in the Buffalo, New York "Niagara Frontier" area. Arrangements have been made for the participating teachers to receive increment credit.

5. **Organization of science teacher groups.** Dinner meetings of such groups where college or university teachers and industrial chemists are asked to speak can help in upgrading teachers' knowledge of chemistry and will go

a long way in "bridging the gap" between high school and college.

6. **Summer employment of chemistry teachers.** Summer jobs in laboratories and science-based industries help teachers earn and learn. Wherever possible, summer school credit or increment credit should be extended for such employment. Employment of high school chemistry teachers as research assistants by colleges and universities during summer months should be encouraged.

7. **Membership in organizations.** All high school chemistry teachers should maintain membership in the National Science Teachers Association and one or both of the American Chemical Society and the American Association for the Advancement of Science. Local sections of ACS cover about 80 per cent of the U. S. population; high school chemistry teachers are cordially invited to attend their meetings.

8. **Scholarships for advanced science training.** Teachers should apply for and take advantage of the numerous scholarships and fellowships offered by various forward-looking industries and the National Science Foundation to enable teachers to attend summer conferences and institutes. Well over 100 summer programs will be offered in 1957, and NSF has indicated that probably 12 to 14 academic-year institutes will receive supporting grants for 1957-58. Unless teachers respond to these opportunities and then participate in a critical evaluation of them looking toward improvement, such support for strengthening science teaching may be curtailed or cut off.

9. **On-the-job needs and opportunities.** Principals and administrators should allow chemistry teachers visiting days. Teachers should show greater interest in, and work toward improvement of, the science section meetings at state and regional teachers' conventions. Also, much can be accomplished through departmental meetings within one's own school system.

The Best Way

The chemistry lectures we have heard during this conference and the informal discussions we have had with the lecturers were dramatic, forceful evidence of the need for chemistry teachers to keep up to date. Some of us had had our last formal course work in chemistry ten, 15, and 20 years ago. But even those of us who qualified for the "only five years ago" category gained much from the experience. We strongly recommend, therefore, that high school chemistry teachers periodically renew and up-date their knowledge of subject matter through formal courses and contacts with college professors of the subject. Opportunities for this should not be confined to summer periods; there are an increasing number of year-round offerings.

Marathon's Willard Stinger, left, explains a process in the Rothschild laboratories.

If this purpose of helping the high school teacher is to be served best, it seems clear that the special needs and situations of such teachers should be kept in mind when instruction is designed. Conventional course offerings in the college departments of chemistry may or may not solve this problem. We were much impressed with the awareness of the needs and teaching situations of high school teachers shown by the college men who served our conference group. We heartily commend the efforts being exerted by the AAAS Science Teaching Improvement Program to encourage more college and university science departments to design and offer courses more appropriate for the future requirements of the prospective science teacher. Likewise, the summer and academic-year institutes sponsored by the National Science Foundation should fill a real need in this respect.

We say these things because we firmly believe that regardless of other considerations, no teacher of high school chemistry can be fully effective and confident without a good command of the subject being dealt with.

SECTION II

Methods of Teaching

The sub-committee for this section of our report recognizes the fundamental importance of the teacher's knowledge of subject matter. We also recognize, however, that such knowledge is no automatic guarantee of effective instructional procedures. Teachers should strive to improve continually in this area as well as in the realm of subject matter.

To promote communication among teachers during the year on ways to help them improve methods for teaching chemistry, two procedures are suggested:

1. The formation of area or regional groups of high school chemistry teachers for discussion, evaluation, and exchanging of personal experiences with problems and methods in the teaching of chemistry. Such groups should enlist the aid of the scientific and educational resources of schools, colleges, industries, and professions to reinforce the program. It was agreed that personal exchanges of method ideas through demonstrations and discussions is the best communicative means. More useful information and ideas were derived through the discussions at this Wisconsin conference than much of the reading any of us has time to do.

Martin Baum, right, of the Marathon Corporation, explains a phase of "science at work in industry" in the Rothschild laboratories.

2. A modest chemistry teachers' newsletter be circulated to members of the group. This could provide coverage of such topics as textbook reviews, audio-visual previews, new sources of teaching aids, and tried and tested demonstrations.

Additional recommendations of this sub-committee are as follows:

3. Bear in mind that most class groups in high school chemistry will, to be sure, include some potential scientists of the future, but they will include many, many more students for whom this course will function as nontechnical, general education. To adopt course content and activities to the two types of students is a challenge to our best efforts. There seem to be no clear-cut guides to "this you do for bright students" and "this you do for all others." The best we know about the psychology of learning suggests that many kinds of teaching procedures and devices will be used with all students. Also, the resourceful teacher will strive for learning situations in which students have made personal identification with the problems or activities to be undertaken. The following suggestions may help chemistry teachers to individualize instruction even in rather large classes.

   —Use of student assistants in the laboratory

   —Use of students to maintain one or more bulletin boards

   —Use of students to give demonstrations to the class

   —Use of individual and group projects

   —Scheduling "help" sessions on difficult topics

   —Scheduling special sessions on topics of special interest to certain students, possibly in a club-type situation

   —Encouraging wide reading of biographical material, science fiction, and supplementary reference materials

   —Encouraging voluntary participation in local, regional, and national programs and activities which offer encouragement and recognition for science projects

   —Encouraging the reading and discussion of materials that tell about the nature and rewards of science-related careers

4. Keep in mind that individualized instruction and the pursuit of diverse objectives clearly imply, in fact, demand, diversified procedures in testing and evaluating student progress and achievement. To evaluate each student at his particular level, objective-form and essay-form tests may be used to "get a measure of" the student's

   —Knowledge and understanding of factual material

   —Understanding of or insight into basic principles

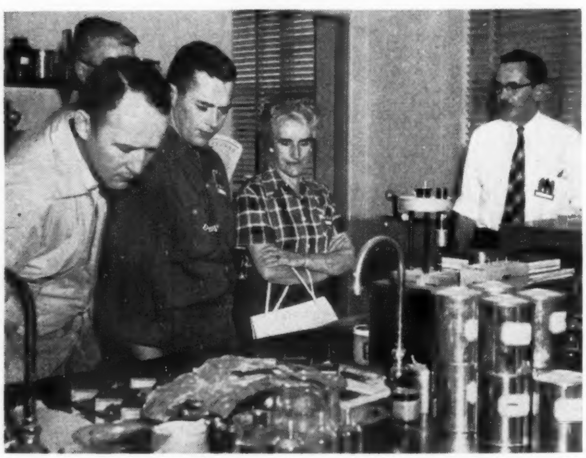
   —Ability to use or apply principles in new situations

   —Ability to observe accurately, as in watching demonstrations

   —Ability to use reference materials in chemistry

   —Skill performance in reading, analyzing, and solving arithmetical problems

   —Ability to record and interpret data such as may be obtained from demonstrations, laboratory work, or field trips



Marathon's John Teeple, at right, explains an operation in the Rothschild research laboratories.

5. Remember that even the above testing procedures may be inadequate to evaluate students in such activities as class laboratory work and individual projects. Anecdotal records, interviews, and other techniques will be used by the teacher who wants to base student reports (marks) on something approaching a full-range assessment of all aspects of instruction in chemistry.

6. A major function of the high school chemistry teacher is to give constructive educational and vocational guidance to individual students. This should involve the results of evaluation, cumulative records, personal observation, and interviews. In many instances, effective student guidance will include interviews and talks with parents.

7. Take time to teach leisurely. Quality is more important than quantity; it is not a crime not to cover the entire textbook. Fewer laboratory exercises of better design will pay bigger dividends than a larger number done in "cookbook" style. Due to the nature of demonstration and laboratory preparations required for the teaching of chemistry, administrators should give more consideration to the teaching loads of high school chemistry teachers. Apparatus must be assembled, cleaned, and put away after use, and repaired when damaged. Write-ups of laboratory work and reports of student projects must be read and should be "corrected" and discussed with students.

8. Arrange for increased participation of students in problems and activities found within the community, industry, and educational agencies. Ways to help students understand how chemistry enters into everyday life include the following.

   —Taking field trips to industries, hospitals, and research laboratories

   —Attending meetings of professional scientific and engineering societies

   —Visiting exhibits of industries and communities

   —Using audio-visual aids offered by industrial and other agencies

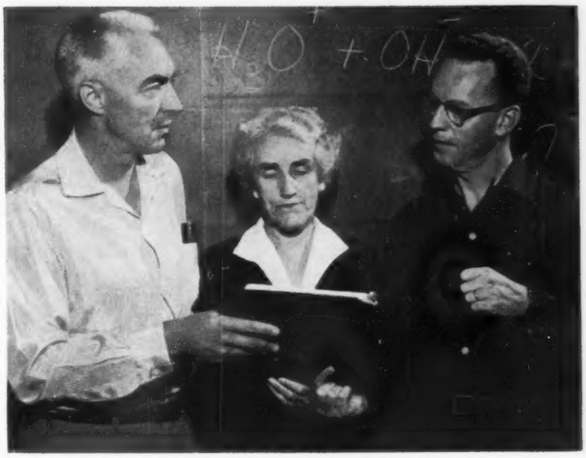
   —Making increased use of mass media such as newspapers, radio, and TV

   —Using resource speakers from colleges and industries

9. Keep the school and department library up to date in chemical literature. The chemistry teacher each year should submit to the school librarian a list of current materials and books that are available and are desired for use in the chemistry course.

10. Lastly, work toward better coordination of science instruction throughout the elementary grades, junior high level, and in other senior high science courses in your school and school system. Are there modifications you can or

should make in high school chemistry because of the earlier experiences your students have had in general science and biology? What can be done to promote increased correlation and reduced, undesirable duplication in chemistry and physics? How closely geared into the work of the mathematics department are the science courses of your school? In what ways do or can you develop correlations of science with English, social studies, home and industrial arts, etc., in your school? These are questions for the chemistry teacher to ponder—and to do something about, in our opinion.



Conference directors, Dr. John F. Baxter, University of Florida Chemistry Professor, left, and Robert H. Carleton, NSTA Executive Secretary, right, discuss a program item with Dorothy Gifford, Chemistry Instructor at The Lincoln School, Providence, Rhode Island. Miss Gifford was the Special Conference Consultant.

SECTION III

Laboratory Activities in Chemistry

It has been said that chemistry is what chemists do. What we find in textbooks is not chemistry; it is the results and the history of chemistry. The body of knowledge and ideas often thought of as chemistry has evolved from inferences drawn from observations made during experimentation. It is the consensus of opinion of this committee, therefore, that suitable opportunities for experimentation, exploration, and discovery be provided for *all* chemistry students. Many students will enjoy trying to rediscover or verify some fundamental principles upon which the science of chemistry has been founded; but it is extremely important that all students have personal and realistic experiences with the methods and attitudes of scientific inquiry.

The use of a laboratory manual, or its equivalent such as teacher-prepared worksheets or guides, appears to be current practice for various reasons such as convenience and saving time. The danger in using these exclusively is that all too often the laboratory work degenerates into a cookbook variety of chemistry. The student does not critically evaluate the evidence from his observations, he does not draw justifiable conclusions, and he often ignores the important item of generalizations and the significant questions: Why? What makes you think so? How would you explain? For these reasons this committee offers a few simple suggestions.

1. We believe the following criteria should be used in selecting and planning laboratory activities.

—Each experiment should be set up as a specific problem to be solved.

—Each laboratory problem should be set up in such a way that students of all levels of ability are challenged to do their best.

—The laboratory problems should begin with the simplest and gradually lead into ones of increased difficulty.

—The study of related textbook or reference literature may be made before or after an experiment as determined by the purpose of the experiment.

—Quality, not quantity, should be the chief criterion for evaluating the worth of the laboratory work throughout the year.

—The experimentation should be of such a nature that the observations, correct conclusions, and generalizations are necessary for the completion of the problem.

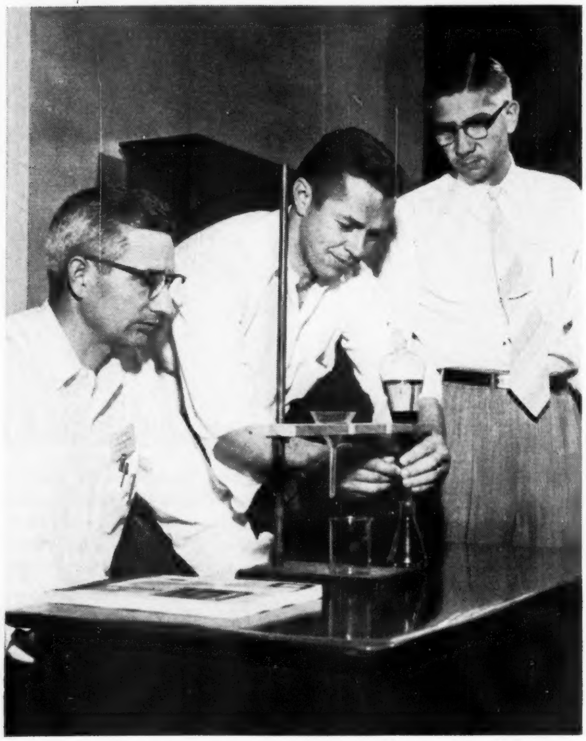
—For the extraodinary student, more encouragement and opportunities should be provided to inspire the student to do further investigations.

—Permeating each experiment should be the scientific point of view and the question: "How do we explain or interpret?"

—Suitable testing procedures should be used for evaluating the results of laboratory work.

—Opportunities for individual project work are essential.

There is great value in projects that can be developed along the lines of the "research team" in which certain students or groups of students



In the laboratory scenes on these two pages, the Fellows are seeing firsthand how industry puts science to work.

may work on different facets of a common problem.

2. We believe the physical characteristics of the laboratory should meet, as closely as possible, the following recommendations.

—The laboratory sections should contain not more than 24 students.

—The laboratory period should run for a minimum of 55 to 60 minutes. Even the traditional laboratory exercises can be adjusted to such a time allotment. Longer time periods for laboratory work are desirable, of course, but it is more important to have a flexible schedule for laboratory work than to be tied to a rigid administrative schedule.

—Laboratory facilities should be adequate to provide opportunities for all students to do much individual experimentation.

—Suitable equipment should be supplied so that skill can be acquired through its use.

—Materials should be conveniently placed so that time may be saved.

—Safety measures should be emphasized and first aid materials should be handy for use in emergencies.

3. We recommend serious consideration of semi-micro equipment and techniques for some or all of the usual high school chemistry laboratory exercises. Potential advantages of semi-micro would seem to be:

—A reduction in the hazards associated with certain laboratory work

—Less space requirement for individual student equipment

—A possible reduction in operating costs

—Greater encouragement of individual student work

—A saving of time in procuring and using reagents

The "How" of It

Criticism regarding the so-called experiments found in most manuals today is not uncommon. The members of this conference feel, however, that perhaps there is more to be corrected in *how* these exercises are used than in the activities basically included. It seems to us that the first requisite is a clear understanding by both the teacher and the students of, "Why do this exercise anyway?" The reason, the goal or purpose, or the problem involved must be boldly underlined; and to the fullest degree possible, it must "make sense" to the students.

If we send 29 students into the laboratory to mix sand and sodium chloride and then separate the mixture by dissolving, filtering, and evaporating to dryness, we must have good reasons for doing so. This is an exercise designed to help students learn some of the ways in which chemists work and some of the apparatus and procedures they use, and to begin developing skill in using these techniques. The next step might well be "a problem situation" in which the new knowledge and skills are put to work. For example: What evidence can you find that each of the following is or is not a mixture?

Commercial fertilizer

Baking soda

Baking powder

Cream of tartar

Simple though it may seem, the above discussion should reveal our strong feelings (1) that time spent in the laboratory should be time well spent in the pursuit of important course objectives, (2) that laboratory work should be done leisurely, unhurriedly, with deep understanding, and (3) that the more frequently and the more completely we can conduct laboratory work on a problem-solving basis, the better. Additional recommendations which we offer for consideration by others are as follows.

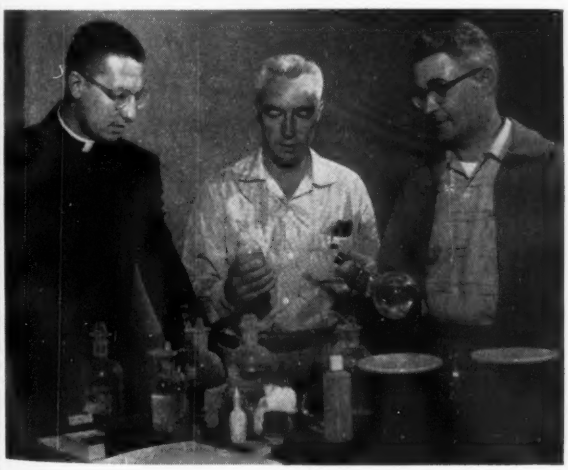
1. Single laboratory manual exercises need not necessarily imply single, separate laboratory periods for each. A number of related exercises may be grouped and students permitted and encouraged to work through them at their own pace, moving from one to the next "with the approval of the teacher." This will contribute to both interest and understanding.

Examples:

A. At the beginning of the year, perhaps as many as eight to ten or more exercises may be grouped as introducing the students to materials, apparatus, techniques and procedures, safety precautions, etc. As soon as these are completed satisfactorily (perhaps through after-school hours as well as during regular laboratory periods), students may move on to other exercises in the manual or to projects or problems based on individual choices.

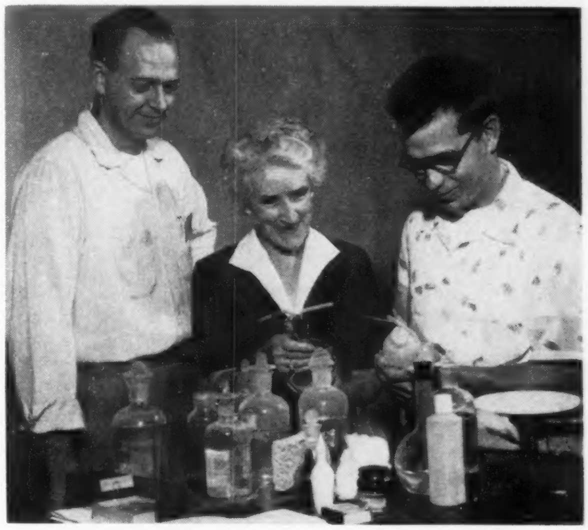
B. A number of well-chosen exercises may be grouped for such units as "Metals" or "Organic Chemistry."

2. Whatever the style of teaching employed, whether problem solving or more conventional approach, students should be persuaded that it is right and honest to enter their own observations into their laboratory records, not necessarily what they "think" is right or what their textbook tells them.



Examples:

A. In the preparation of oxygen from potassium chlorate and manganese dioxide, the student usually observes a cloudiness and an acrid odor in the gas. The textbook says that oxygen is colorless and odorless. The student should be habituated to report what he observes and to offer tentative explanations for differences from accepted facts.



B. Nitric oxide is described as a colorless gas. But in its preparation the gas within the generator bottle is usually brown. Here is another case where students should be encouraged to note discrepancies from the text and to attempt an explanation. The nature of the attempt is, of course, more important than how nearly correct it is.

3. Students, or many of them at least, should be encouraged to carry out related and ramifying facets of the basic exercise.

Examples:

In many preparations have the student study the by-products as well as the principal product. There are students who, *given time and encouragement,* will derive great satisfaction from making a quantitative study of the potassium chlorate, manganese dioxide, and potassium chloride involved in the reaction for making oxygen.

4. Projects related to or growing out of the labora-

tory work (as prescribed in the manuals) should be encouraged. Some may be relatively simple and little time required for their completion; others may be more involved and extend into weeks or months for their completion.

Examples:

A. Some of the earliest exercises usually done require evaporation and crystal formation. This may lead into extensive projects on the growth and study of crystals such as the alums, cupric sulfate, potassium ferricyanide, etc.

B. A laboratory manual study of acids and bases may grow into a project on soil testing.

C. Out of the usual laboratory work on nitrogen compounds there may develop a deep-rooted interest to carry on projects with hydroponics.

Nurturing Curiosity

It is the feeling of this subcommittee that the greatest shortcoming of the conventional laboratory manual exercise in high school chemistry is its failure to stimulate or provide opportunity for the student to explore, discover for himself, and satisfy his scientific curiosity. Each and every step is directed; short-answer questions are asked or "blanks to fill in" are provided. We have suggested some ways by which many of these exercises can be modified so as to overcome such shortcomings and achieve higher goals to a greater degree. It is primarily through projects, however, that self-directed and more purposeful laboratory activities come about. Some of the students will find problems and projects for themselves; others may need stimulating suggestions and help, at least at the outset. Undoubtedly there will be students to whom such activity has little or no appeal—and for these we would suggest continuing "performance" of the laboratory manual exercises, believing that little or nothing is gained by requiring or forcing students into projects.

On a tour of the Institute of Paper Chemistry museum, two Fellows inspect an old paper press from Somersetshire, England, that dates back to 1790.

By project, we mean a special study or line of investigation carried out by an individual student, or perhaps by small groups or teams of students. The teacher's job is to motivate genuine student interest and then skillfully nurture and maintain it. This, we realize, is a skill not easily communicated by mere words. In fact, not all of us in this conference group were totally confident we could do this ourselves when we resumed teaching in the fall—but we were committed to a supreme effort to try! Here are some guidelines we decided to count on to help us.

1. Seek to locate, suggest, and encourage projects of simple to more complex design so as to offer problems that will challenge and stimulate a wide range of student abilities and interests.

2. Organize and/or use the science club as a forum for extending and exchanging student experiences with projects.

3. Get started early. Even the first or second week of school is not too early to introduce the idea and practice of projects.

4. Call upon the many resource persons to be found in almost any community—people employed in science-related professions and occupations who will be happy to work with teachers and students engaged in science projects: the county agricultural agent, the chemist in a paper plant, the service manager for an automobile dealer, and so on.

5. Get ideas from periodicals, reference works, and publications available to chemistry teachers. Among these would be *The Science Teacher*, *Scientific American*, *Journal of Chemical Education*, *Chemistry*, and other periodicals and the several pamphlets and booklets put out by the National

Science Teachers Association, the American Chemical Society, and Science Service. This is not a complete listing of helpful publications, but each of these will likely provide bibliographies for further reference.

6. Participate in various meetings of science teachers where exchanges of experiences and ideas are an important part of the program offerings.

Time off: A scene in the dormitory

7. Be patient and don't try to move from zero or close to zero all the way to the boiling point in one grand swoop. Big successes with student projects may well be achieved best by having numerous little successes at first.

8. Let the students help you. Allow time for students who have done projects to tell others about their work. Let this year's students hear about the project successes and honors gained by students of former years. Name the students; perhaps some of their younger brothers and sisters or friends are in this year's classes.

9. Continually "keep an eye" on the types of activities in which the students are engaged lest some drift into unguided dabbling of little educational worth. It is not necessary that all students be working on projects all the time; but it is vitally important that projects have purpose, and that at appropriate times their relatedness to the on-going classroom study is made clear. The latter should, of course, be done by students reporting to the class.

10. Students should be encouraged to report their projects outside as well as in the classroom. Reports can be submitted in the Science Achievement Awards program and for publication in *Tomorrow's Scientists.*

Ideas for Projects

An important phase of our conference consisted of the reporting, or sharing, shall we say, of experiences with student projects and problem investigations. As space allows, we pass these along to our readers, hoping that they may be as helpful to you as we are sure they will be to us.

1. Having prepared oxygen from mercuric oxide, two girls teamed up to find out whether this element could be obtained from other, apparently similar oxides and from other compounds containing oxygen. They used iron rust, magnesium oxide, zinc oxide, limestone, red lead, sodium bicarbonate, and copper nitrate.

2. The usual laboratory exercise on the destructive distillation of wood and coal suggested to one boy that he might get some interesting results from the similar treatment of coffee.

3. The making of a collection of samples of as many elements as obtainable, and their arrangement in accord with the periodic chart, served not only as a stimulating student project but also provided a useful teaching aid for years to come.

4. What is the vitamin C content of several brands of orange juice? What happens to the vitamin C content of a given brand of orange juice (a) during various time periods of exposure to air at room temperature, (b) as a result of heating to a specified temperature? Reference texts on food analysis will suggest procedures.

5. Many "consumer chemistry" type projects will occur to students if one or two suggestions are used as stimulation. Which of three brands of baking powder gives the most CO_2 per unit cost, say, per penny? Similar questions can be asked about the basicity of milk of magnesia or household ammonia water. How can household bleaches be compared? Antifreezes?

6. Some students are more academically inclined than others. Constructing solid-state models of ideas about the structure of alloys, organic and inorganic molecules and ionic configurations, and the behavior of solids will appeal to many such students.

7. An interesting case was reported in which a student couldn't think of a project and asked his teacher for help. The teacher suggested he choose some chemical reaction, carry it out quantitatively in the laboratory, and compute the per cent of yield. The boy chose the reaction of lead nitrate and

The head table at the banquet session: left to right, Dorothy Gifford; Allen Abrams, Vice-President (retired), Research and Development, The Marathon Corporation; Harry A. Johnson, toastmaster; President Douglas Knight of Lawrence College, the speaker; Harry F. Lewis, Vice-President, The Institute of Paper Chemistry; Violet Strahler, visiting lecturer; and John F. Baxter.

hydrocloric acid in solution; then he calculated the yield of lead chloride. His results repeatedly were far below expectations. Together, the boy and his teacher began to look for an explanation; they read about the formation of soluble complex ions when lead chloride is in the presence of excess concentrated hydrochloric acid. The boy became interested in the broad subject of complex ions and went on to extended, major study in this field.

8. How can you determine how much oxygen, if any, remains in exhaled air? What is the effect of exercise on this?

9. Preparing as many different derivatives as possible from a chunk of limestone is the kind of project that can be adapted to a wide range of student abilities.

10. A "future chemical engineer" in the class may be interested in a project like this: Starting with 5 lbs. of table salt (sodium chloride), manufacture as much hydrochloric acid as you can from it. Determine the characteristics or specifications of the acid and compute the per cent of yield.

11. Studies of food and nutrition, leaf colorings, enzyme actions, and the like afford opportunities for students to combine their chemistry with previous learnings and experiences in biology.

12. Excellent sources of project ideas for students include the annual published lists of entries or winners in the Science Achievement Awards program of the Future Scientists of America Foundation and the Westinghouse Science Talent Search. The new publication of the National Science Teachers Association, titled *Tomorrow's Scientists*, provides both suggestions for student projects and an outlet through which students can report and have their work published. This publication features student-written articles and these carry the by-line of the student author.

13. The mere listing of "topics" suggested for student project study may help some students to get started. You, as the teacher, must, of course, be prepared to suggest specific problem approaches if necessary.

Here are a few such topics:

Effects of Quenching Media on Steels
The Solar Battery
The Metallurgy of Aluminum
Why Does Popcorn Pop?
Separation of Components of Beef Blood
Effects of Detergents on Materials
Alloy Analysis by Paper Chromatography
Ion Exchange Resins and Their Uses
Cosmetic Chemistry
How Lubricants Affect Abrasion of Metals
Controlling the Slipperiness of Floor Wax
The Structure of Metallic Hydrides

14. Some students will be interested in projects that involve the construction of equipment and apparatus which may be used now and in years ahead for classroom demonstrations.

Examples:

Improved Electrical Conductivity Apparatus
Molecular Models of Organic Compounds
Device to Illustrate the Structure of Atoms
Model of the Blast Furnace
Diorama of the Age of Coal-Making
Cross Section Model of Oil Field

15. Charts and diagrams are important teaching aids found in most textbooks. Many of these can be reproduced in modified form, in colors, and with attachments to make bulletin board displays or other audio-visual aids useful to the teacher. The construction of such aids can be significant projects for students.

Suggestions are as follows:

The Chemical Composition of the Human Body
What Comes From a Barrel of Petroleum?
What Comes From a Bushel of Corn?
What Comes From a Ton of Coal?
Mineral Composition of the Earth

16. The interest of many students will be nurtured or whetted if they are encouraged to study, try out, and demonstrate to the class certain rather spectacular demonstration experiments. Some examples are given in the following listing, directions for which may be found in chemical literature.

Ammonium Amalgam
Zinc Ethyl
Dust Explosion (use pump; do not blow)
Wood's Metal
Solidified Alcohol ("canned heat")
The Goldschmidt ("thermit") Reaction (care!)
Time Reaction ("clock reaction") of Iodic Acid
Foam-type Fire Extinguisher
A Supersaturated Solution
Oxidation of Amalgamated Aluminum
Formation of Fog or Cloud
Liquid Air (possibly a group activity)
Adsorption by Activated Charcoal
Spontaneous Combustion
Oxidation of Ammonia

17. Some teachers have felt quite statisfied with the results of suggesting to certain students that they "take a principle of chemistry" and prepare a discussion of it, together with suitable demonstrations, for presentation to the class. This, incidentally, may be one way to detect students with the potential of becoming science teachers.

Examples of such projects are as follows:

Oxidation-Reduction Reactions
The Chemical Activity of Metals
Factors Affecting the Rates of Reactions
Amphoteric Character of Metals
Evidence for the Molecular Theory
Hydrolysis Reactions
The Behavior of Colloids
Corrosion of Metals

In Conclusion

We who were participants in this conference for Wisconsin chemistry teachers want to extend our sincere thanks and appreciation to the many individuals and groups who contributed so much to its success. The experience for us was wonderfully satisfying professionally and as a summer interlude before returning to classroom duties within a day or two after the conference closing.

Our social activities—the banquet and attendance at the Appleton Community Players' performance of Shaw's "Man and Superman"—and our field trip to the Marathon research laboratories and plant at Rothschild, Wisconsin and to the Trees for Tomorrow conservation camp and project at Eagle River, Wisconsin were welcome changes of pace in the conference schedule. Thanks to all who helped in these activities.

It is hard for us to imagine any conference group being better fed or housed than we were at Brokaw Hall, Lawrence College. College officials and dormitory staff have already been told, but we also want our appreciation expressed in print.

We thank particuarly the conference leaders who were provided in the persons of Miss Dorothy Gifford, Lincoln School, Providence, Rhode Island; Dr. John F. Baxter, University of Florida, Gainesville; Dr. Harry F. Lewis, the Institute of Paper Chemistry, Appleton, Wisconsin; and Mr. Robert H. Carleton, National Science Teachers Association, Washington, D. C. As one of our Fellows said, "It is remarkable how heavily their finger touches the pulse of chemistry teachers so that they knew exactly what we needed and wanted out of this conference."

Our visiting lecturers were "tops" and we want everyone to know that their knowledgeable and inspiring lectures and discussions were highlights of the conference. So, "thank you" to: Dr. William A. Kieffer, The College of Wooster, Ohio; Dr. Arthur Campbell, the National Science Foundation, Washington, D. C.; Dr. Robert Rosenberg, Lawrence College, Appleton, Wisconsin; Brother Fred Weisbruch, Don Bosco High School, Milwaukee, Wisconsin; Miss Violet Strahler, Stivers High School, Dayton, Ohio; Dr. Milton O. Pella, Uni-

versity of Wisconsin, Madison; Dr. J. A. Van den Akker, the Institute of Paper Chemistry, Appleton, Wisconsin.

We understand that an Advisory Committee assisted in the design and planning of our conference and we want this group to share our appreciation: Dr. B. R. Stanerson, American Chemical Society, Washington, D. C.; Dr. Benjamin D. Van Evera, George Washington University, Washington, D. C.; Mr. Charles A. McCalla, Montgomery Blair High School, Silver Spring, Maryland; Dr. Ellsworth S. Obourn, U. S. Office of Education, Washington, D. C.; and Dr. Saylor Cubbage, Woodrow Wilson High School, Washington, D. C.

To the Marathon Corporation, whose financial support made the conference possible, we express not only our own gratitude but, we firmly believe, the gratitude of thousands of our colleagues throughout the nation. This form of recognition of the important role of the high school chemistry teacher is a tremendous boost to our enthusiasm and morale. This result may be even more important than the take-home values gained by the 36 conference Fellows. It is our fervent hope that Marathon will continue this conference for Wisconsin high school chemistry teachers for many years; also, that many other companies will join in cooperating with our national association's Future Scientists of America Foundation and with collegiate institutions to provide hundreds or thousands of other chemistry teachers with similar opportunities for summer study.

As the Fellows Said:

"A conference such as this stimulates one to sit back and take a good look at himself—what he is doing and how and why. So often in the rush of teaching, we overlook methods and logical sequence in our hurry to 'cover the facts.' "

"Although I have been teaching only six years, I was amazed to find how many things have changed in these few years. Chemistry changes so fast that I feel a conference of this type should be a 'must' for the chemistry teacher every few years."

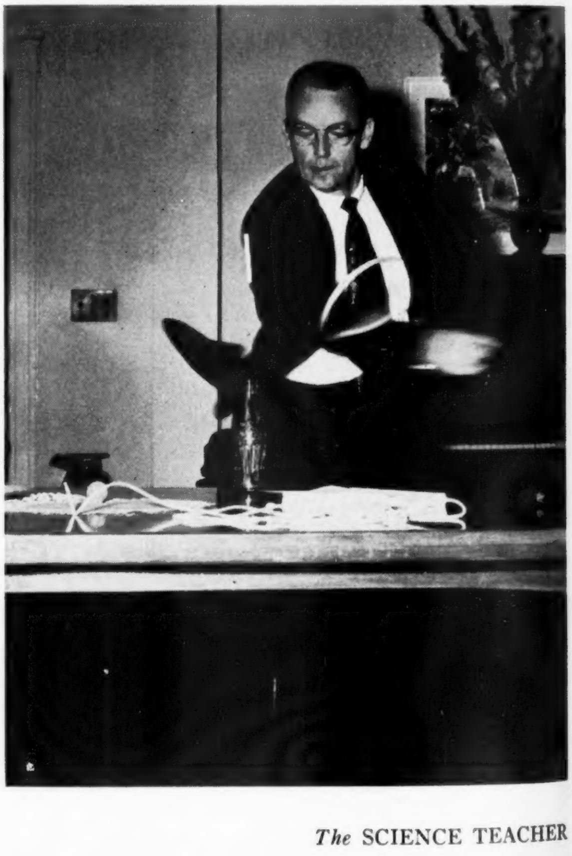
"When I first heard of this conference I asked myself, 'Just what will it accomplish and what will I as a participant get out of it?' I admit I was one of the skeptics—assuming it might turn out to be just another one of those things. After the first session I began to see I had a surprise in store. Each succeeding day brought new challenges. Not only do I feel I have been brought up to date on the newer concepts and theories in the field of chemistry but have gained a different slant on the areas of 'core materials,' presentation, and teaching procedures for my classes."

"The conference has been stimulating. Baxter has caused me to discard so much that I 'knew' and take in its place something I'm not sure of—a self-complacency on subject matter. As for teaching, I found out I'm not doing the worst job possible, but I'm certainly not doing the best either."

"This conference provided a great opportunity to meet personally with fellow teachers of my area, college chemistry teachers, leaders of national professional organizations, and other outstanding persons in the science fields. Through the field trips, lectures, and discussion groups I have gained a new insight into industrial methods, research techniques used by industrial scientists, and the scientist's role in the pulp and paper industry."

"I was greatly impressed with the way this conference was designed and conducted. The free exchange of ideas and experiences was worth a lot. I'm convinced I'm prepared to do a better job this year—through my mental attitude toward the whole business if for no other reason. The sponsor is to be commended for making the conference possible. Education needs more of this kind of thing."

NSTA's Executive Secretary in a "serious" mood: "Bob" Carleton, conference co-director, displays his magical skills to provide the Fellows with off-study entertainment.



A PROGRAM OF ACADEMIC-YEAR INSTITUTES FOR HIGH SCHOOL SCIENCE TEACHERS

A Report on National Science Foundation Grants

This report on the academic-year institutes represents one phase of NSTA's program for keeping science teachers informed on fellowships and summer opportunities. In addition to articles and announcements in *The Science Teacher*, reports are also made through individual mailings to science teachers. The February 1957 *TST* will feature a general listing of upcoming fellowship and other summer opportunities which in 1957 will include 95 National Science Foundation grants for the support of summer institutes for high school and college teachers of science and mathematics.

APPROXIMATELY 750 high school science and mathematics teachers will attend academic-year institutes next year under a new program of grants announced by the National Science Foundation (NSF). The grants, totaling $4,065,000, have been awarded to 16 U.S. colleges and universities for institutes designed to help science teachers improve their knowledge of science subject matter.

The institutes will begin in September 1957. The grants will provide stipends of $3000 each to approximately 50 teachers in each institute. There will be additional allowances for dependents and travel. Each teacher will follow a program of study in the sciences and mathematics planned especially for him or her, and conducted by leaders in their respective fields.

Teachers interested in taking part in the program should contact the director mentioned in the listing below of the 16 colleges and universities where the institutes will be held. Do not write to NSF or to NSTA. And now is the time for institute applicants to start collecting letters of recommendation and records of college credits. These should be immediately available when application forms are filed.

Academic-year institutes are an outgrowth and extension of the Foundation's summer institute programs, now in their fifth consecutive year. Two academic-year programs are now operating, at the University of Wisconsin and Oklahoma Agricultural and Mechanical College. These two are being renewed under the 16-institute grants. The institutes will provide work in the various fields of science as well as mathematics, with the exceptions of the University of Chicago and the University of Illinois institutes which will be for teachers of high school mathematics only.

The 16 directors of the institutes met in Washington, D. C. at the end of November to work out details of the program with each other and with National Science Foundation officials.

The new grants program was announced by Alan T. Waterman, Director of the Foundation, which is an independent agency of the Federal Government. Pointing out that the peak high school population is continuing to grow, Dr. Waterman said that the present supply of and future need for highly capable high school science and mathematics teachers "constitute the most critical and difficult problem in the effort to maintain an adequate supply of top quality scientists and engineers. This places a tremendous responsibility on today's high school science teachers. In order to help them, the Foundation is attempting to provide an opportunity for intensive training in the scientific subjects taught in high school through an enlarged program of academic-year institutes, established in colleges and universities widely scattered across the Nation."

The locations of the 1957-58 academic-year institutes and the director of each are:

HARVARD UNIVERSITY, Cambridge, Massachusetts
Professor Edward E. Kemble, Department of Chemistry

OHIO STATE UNIVERSITY, Columbus 10, Ohio
Professor John S. Richardson, College of Education

OKLAHOMA AGRICULTURAL AND MECHANICAL COLLEGE, Stillwater, Oklahoma
Professor James H. Zant, Department of Mathematics

OREGON STATE COLLEGE, Corvallis, Oregon
Professor Stanley E. Williamson, Department of Science Education

PENNSYLVANIA STATE UNIVERSITY, University Park, Pennsylvania
Mr. William H. Powers, Arts and Sciences Extension

STANFORD UNIVERSITY, Stanford University, California
Professor Harold M. Bacon, Department of Mathematics

WASHINGTON UNIVERSITY, St. Louis, Missouri
Dean T. F. Hall

UNIVERSITY OF CHICAGO, Chicago 37, Illinois
Professor E. P. Northrop, Mathematics Staff

The institute directors at the November meeting with National Science Foundation officials in Washington, D. C.: First row, seated, left to right—Richardson, Zant, Anderson, Sorum, Bacon, Briggs; second row, standing—Williamson, Parmley, Miller, Landin, Kemble, Cole, Markham, Hall, Powers, Northrop; third row, standing—Harry C. Kelly, Assistant Director for Scientific Personnel and Education, NSF, J. A. Campbell, Program Director for Summer Institutes, NSF, Urner Liddel, Program Director for Academic-Year Institutes, NSF.

UNIVERSITY OF COLORADO, Boulder, Colorado
Professor William E. Briggs, Department of Mathematics

UNIVERSITY OF ILLINOIS, Urbana, Illinois
Professor Joseph Landin, Department of Mathematics

UNIVERSITY OF MICHIGAN, Ann Arbor, Michigan
Professor Freeman D. Miller, Department of Astronomy

UNIVERSITY OF NORTH CAROLINA, Chapel Hill, North Carolina
Professor Edwin C. Markham, Department of Chemistry

UNIVERSITY OF TEXAS, Austin 12, Texas
Professor Robbin C. Anderson, Department of Chemistry

UNIVERSITY OF UTAH, Salt Lake City, Utah
Professor T. J. Parmley, Department of Physics

UNIVERSITY OF VIRGINIA, Charlottesville, Virginia
Professor James W. Cole, Department of Chemistry

UNIVERSITY OF WISCONSIN, Madison 6, Wisconsin
Professor C. H. Sorum, Department of Chemistry

Fellowships for College Science Teachers

Another National Science Foundation program of interest to science teachers provides for the award of approximately 100 Science Faculty Fellowships. The deadline for completed applications is January 14, 1957. The awards will be announced on March 20, 1957.

These Fellowships are for college or university teachers of science, mathematics, and engineering, and are designed to help the individuals improve their competence as teachers.

Among the requirements for applicants, who must be citizens of the United States, are the following: A baccalaureate degree or its equivalent, demonstrated ability and special aptitude for science teaching and advanced training, not less than three years of experience in teaching science at the collegiate level as of January 1, 1957, and the intention to continue teaching. Applicants must submit an "Active Program," an individualized plan of study and/or research.

The stipends for the Science Faculty Fellows will be individually computed to give the fellowship holders approximately the same income as received from their normal salaries. Including supplemental support, the maximum will be $10,000 per year. The minimum stipend provided by the Foundation will not be less than $2000. In all cases Faculty Fellows will be assured an income of not less than $4000 per year. An allowance to help pay travel costs will generally be paid, in addition to the stipend.

The normal tenure of the Fellowships will be one year, either the nine-month academic year or the 12-month calendar year.

The Fellows will be selected on their potential and demonstrated ability as teachers of science. The selection will be based on letters of recommendation, academic records, and other appropriate evidences of professional activity and competence. Applicants' qualifications will be evaluated by panels considered especially competent to judge the teacher's ability.

Application materials may be obtained from the Division of Scientific Personnel and Education, National Science Foundation, Washington 25, D. C.

PRESSURE VARIATION AND THE RADIOSONDE

By M. IRA DUBINS

Assistant Professor of Science Education, Northwestern University, Evanston, Illinois

WITH more than 50 U.S. Weather Bureau, Air Force, and Navy meteorological stations sending at least two radiosondes aloft daily, students now frequently bring one to the classroom and ask the teacher for an explanation of it and its use.

Radiosondes are attached to balloons which ascend to an average of 100,000 feet above sea level. Once the balloons burst, the radiosondes float to the earth's surface by parachute. Radio signals denoting the pressure of the atmosphere, the temperature, and the relative humidity at different levels of the atmosphere and strong enough to be heard more than 100 miles away are sent out during the ascent and descent of the radiosonde. This information is invaluable to the weather forecaster and to the pilot.

The student who finds a radiosonde (they land all over) can quickly and accurately identify it by its inscriptions.

This appears on the white box:

SIGNAL CORPS	U.S. ARMY
RADIOSONDE MODULATOR	
Model No......................	Order No......................
Serial No......................	
Friez Instrument Div.	Bendix Aviation Corp.

This appears on the transparent, plastic tube:

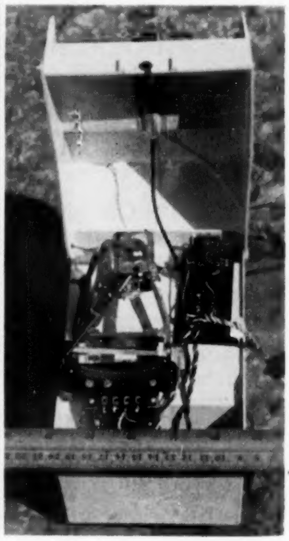
SIGNAL CORPS	U.S. ARMY
RADIOSONDE TRANSMITTER	Model No......................
Ser. No......................	Order No......................

FRIEZ INSTRUMENT DIVISION
BENDIX AVIATION CORPORATION

Radiosondes consist of the modulator and the transmitter. The modulator consists of weather instruments and some electrical parts housed with batteries in a white box. The box is light, plastic, and waterproof. It is five inches by six inches by 6.5 inches. The transmitter is in a transparent, plastic, conical tube, two inches in diameter and eight inches long, which is attached and plugged into the box.

The radiosonde is an ingenious instrument. It measures the atmospheric pressure by means of an aneroid cell, the same type that is found in the non-mercury barometer that rests on many a mantlepiece. As the pressure decreases, the metal cell which is almost a vacuum expands, pushing an arm, or pointer, which makes contact with an electrical circuit. As a result, radio signals denoting atmospheric pressure are sent out.

The radiosonde measures temperature by the electrical resistance of a wire. One of the properties of metal wire is that, as the temperature decreases, its electrical resistance decreases permitting electricity to flow more easily. This is reflected in the radio signals which are then transmitted. The relative humidity, or percentage of moisture present in the air to the amount of moisture the air would hold when it is saturated, is measured by the electrical resistance of a chemical, lithium chloride, whose resistance varies according to the amount of moisture in the atmosphere.



Radiosonde (left). The white box is the modulator. The tube resting on top of the box is the radio transmitter.

Radiosonde Modulator (right). The left half consists of the aneroid cell, its arm (or pointer), and the electrical circuit with which it makes contact. The pointer is to the right of the aneroid cell and extends down to the left. If it were continued, it would intersect the ruler at 3¼ inches. A relay is in the back left corner.

At the station which sends out the radiosonde there is a receiver which tracks the balloon and receives the signals. The balloons can travel considerably more than 100 miles due to the strong winds often encountered above 20,000 feet. Power is supplied for the radio transmitter by a battery made of cuprous chloride and magnesium.

The teacher can simulate conditions in the upper atmosphere by placing the radiosonde modulator inside a bell jar attached to a vacuum pump. Before doing this, remove the transmitter by pulling out its plug from the modulator and turning its base so that it can be slid out of its holder on the top of the modulator.

As the air is removed from the bell jar, a copper pointer will move to the right, just as if the balloon were carrying the radiosonde aloft. Close the valve in the bell jar and turn off the pump. The pointer stops. Remove the rubber tube from the bell jar valve. Open the valve so that air will be admitted. This is equivalent to the descent of the radiosonde. The pointer moves to the left and soon, when the pressure inside the jar is the same as that outside the jar, the pointer will be at its original position.

This demonstration can be done at the secondary level in general science, physics, and physical geography. It can also be done at the elementary level when the class is studying a unit on weather. The elementary school teacher should borrow the equipment from the high school physics teacher and be checked out on its operation.

As a related activity the pupils can be told about the construction of the aneroid barometer and its use in the altimeter.

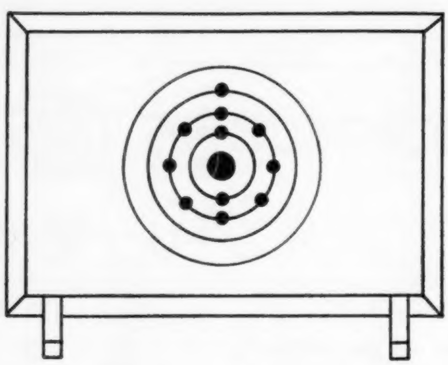
Classroom Ideas

Chemistry

A Simple Model for the Structure of the Atom

By WESLEY W. WENDLANDT, Assistant Professor, Texas Technological College, Lubbock

Students in general science and chemistry classes frequently have difficulty in understanding the arrangement of the electrons in the atom. The simple model illustrated can be used to show the electron arrangement.



Schematic Diagram of the Flannel Board

The model consists of a flannel board, of convenient size, which can be easily obtained. A small wood base is attached to the wooden frame of the panel to hold it in a vertical position. To illustrate the energy levels of the electrons, circles are drawn on the flannel with white chalk (black chalk if the flannel is a light color) at about two-inch intervals. A total of four circles is the most convenient to use.

The electrons are represented by small circles of about one inch in diameter cut from poster board and having a piece of sandpaper glued on the back, rough side outward.

To illustrate the electron arrangements of the simple atoms, the electrons are pressed to the respective circles on the flannel board. Only a slight pressure is needed to hold the electrons firmly in place. To illustrate compound formation between atoms by electron transfer, the electrons are either added or removed from the board.

Biology

Genetics a la Chinese Checkers

By EDNA L. MEADOWS, Stephen Decatur High School, Decatur, Illinois

With some discarded marbles from a Chinese checkers game, a piece of scrap lumber, and cooperation from a woodshop teacher, the science teacher can have a fascinating visual teaching aid for the class heredity unit.

Although genetics is an intriguing subject to many students, dihybrid crosses often remain a puzzle to even the superior student. One difficulty seems to develop as they try to determine possible gametes. Another puzzle arises as the pupils try to visualize the results from the union of gametes. Punnet squares drawn on the blackboard solve the mystery for some; others are more perplexed than ever. With the chance remark of a former student that this process resembled Chinese checkers, the thought occurred to me that perhaps Chinese checkers could be a game in heredity teaching. With this in mind and a diagram in hand, I described my plan to our woodshop teacher. The pictured board was soon in my classroom.

Parents with heterozygous pairs of chromosomes are represented by marbles in the top row. In the row below, gametes are determined and placed in position. The F_1 hybrid may be expected to produce four kinds of gametes in approximately equal numbers. Here the "addition method" of determining possible gene combinations may be taught visually. Thus far the principles of dominance and segregation have been

In the device pictured here, the holes are 7/16ths of an inch in diameter, drilled to a depth of 1/8 inch and spaced one inch on centers. The horizontal and vertical bars, which are 1/8 inch wide, are spaced two inches on centers.

demonstrated. In the Punnet square the 16 possible combinations are arranged, thus illustrating the principle of independent assortment. The phenotype and genotype of each expected offspring are easily seen. Ratios become more meaningful.

Students are always interested in learning why it is possible for brown-haired, brown-eyed parents to have a blonde-haired, blue-eyed child. With beginning students, teachers, in general, have assumed the complete dominance of the brown factor in hair color and eye color. Brown hair may be represented with a black marble, the blonde hair with a yellow marble, the brown eyes with a brown marble, and blue eyes with a blue marble. Pupils immediately find the homozygous recessive individual.

The same board lends itself to displaying seeds as well as marbles. The classic examples of the cross of yellow round peas (F_1) with green wrinkled peas (F_1) and the resulting (F_2) possibilities provide striking examples of a dihybrid cross. With expansion of this principle and a larger board, it would be possible to show the result of a trihybrid cross.

NSTA Activities

Life Members

The continuing growth in membership is something all NSTA-ers can be proud of. One notable yardstick is the jump in the number of Life Members. Since the publication of the last list in the May 1956 issue of *The Science Teacher,* a record 48 names have been added to the Life Membership roll. There are some interesting things about the new list. Represented are 18 states, in all parts of the country, the District of Columbia, and Guam. Three of the new Life Members are from the Science Department of the Huntington Beach, California, High School. Huntington Beach now has five NSTA members—the whole Science Department at present—and four of them are Life Members. There's a report that the fifth teacher is being "worked on" by his colleagues to change his status, too.

The roll of new Life Members since last May is on page 393 of this issue.

Looking Forward

The end of the year is the time for looking ahead and NSTA has a full calendar of events for you to make note of, not only for the coming year but for the year after that, too. Here's the schedule:

December 26-30, 1956: New York City meeting in conjunction with the annual meeting of the American Association for the Advancement of Science. (If you live in the eastern region, you've already received your program. If you live elsewhere and will be in New York City during the Xmas-New Year holidays, write NSTA headquarters for a copy of the program.)

March 20-23, 1957: Fifth National Convention of NSTA, Cleveland, Ohio.

June 24 and 25, 1957: Northwest regional meeting, Washington State College, Pullman.

July 1, 1957: Annual summer meeting, Philadelphia, Pennsylvania. (In conjunction with the NEA Centennial Convention.)

October 18 and 19, 1957: Northeast regional conference, Hartford, Connecticut.

December 27-30, 1957: Annual winter conference, Indianapolis, Indiana. (In conjunction with the annual AAAS meeting.)

And newest news—March 26-29, 1958: Sixth National Convention of NSTA, Denver, Colorado.

The behind-the-scenes work that makes all these meetings possible—and successful—is already going on, even for the Denver Convention. For each event, at least 25 to 30 teachers are now hard at work, planning every single detail from programs to hotel reservations. If you've not yet helped on a meeting, would you like to? Maybe you'll be assigned to "scrub-work;" maybe you'll find yourself a panel speaker. One thing you can be sure of: Perhaps your arms and your feet will ache after many a day of hard work, but at the end of it all, in that final "shoes-off" session, you'll have the fine satisfaction of saying, "It *was* a good meeting . . ."

STAR: Second Year?

December 21 is the deadline for the STAR awards program, so you have only a little time left if you haven't sent in your entry (see page 251, September *TST*). If you've been thinking you'd wait until next year, here's a warning: At present it appears unlikely that the STAR program will continue, at least in its present form. The grant for the program from the U. S. National Cancer Institute was for only one year. Therefore, if the program is to continue, another sponsor is needed. Until that question is settled, *now* is the time for you to try for the $200 cash award (or a three-day all-expense trip to Washington). Entries must be postmarked not later than December 21, 1956.

You and Convention

Do you have a demonstration of which you are particularly proud? Or, have you developed a teaching "gimmick" which other science teachers could use? If you can answer "yes" to either of these queries, there's a place for you on the program of the Fifth National Convention of NSTA, at Cleveland, Ohio, March 20-23, 1957. Your planning committee has set aside a special time for teaching ideas contributed by members—on Saturday, March 23. Each of the major high school science fields—general science, biology, chemistry, and physics—will have its own meeting place and program. Send the title of your paper, its approximate length in time, and the special things

you'll need (electrical power outlet, projection screen, etc.) to Professor James G. Harlow, Chairman, NSTA Program Committee, Department of Education, University of Chicago, Chicago 37, Illinois. Share your ideas with your colleagues! Here's your best chance!

Apparatus and Equipment

The Apparatus and Equipment Committee of NSTA is developing a new program for the study and evaluation of apparatus and equipment used in teaching the sciences in junior and senior high schools. The commitee wishes to get assistance from all science teachers to help determine the scope and direction of its work.

For example, the committee would like your answers to these questions:

Are you now using items of equipment which you consider unsatisfactory?

Do you have in your laboratory an item of equipment which you do not use because of lack of knowledge, insufficient instructions from the manufacturer, faulty design, or any other reason?

Do you have need for some type of equipment which is not now available?

Do you know of any type of equipment you would like to purchase if it were evaluated first and recommended by the NSTA committee?

Please write your answers to any member of the committee listed below. Also let the committee members know if they can help you in any special way. State your problem in detail and give itemized information on items of equipment you mention so they can be easily identified.

The committee members are:

Dr. Robert A. Bullington, Illinois State Teachers College, DeKalb, Illinois, *Chairman*

Dr. Richard Armacest, Purdue University, West Lafayette, Indiana

Mrs. Muriel Beuschlein, Chicago Teachers College, Chicago 29, Illinois

Dr. Ira Dubins, School of Education, Northwestern University, Evanston, Illinois

Mrs. Emilie Lepthien, Board of Education, 2230 W. Courtland Street, Chicago, Illinois

Mr. Nelson Lowry, Arlington Heights Township High School, Arlington Heights, Illinois

The Science Teacher

This is your first December issue of *TST* and it also marks the completion of *TST*'s first editorial year of eight issues. That's the 1957 schedule, too, with the February issue inaugurating Volume 24. Your editors are already planning some special issues and probably a few new features. Have you any ideas for *TST*? Are there features you'd like to see added? Write the editors your suggestions.

FSA Activities

Tomorrow's Scientists

The first reactions to *Tomorrow's Scientists,* the new publication for science students, are in and they are unanimously favorable. Both the content and make-up of the eight-page paper are being praised and the compliments are accompanied by a mounting number of subscription orders. The editorial schedule now calls for at least four issues during the first half of 1957, dated January, February, March, and April. Three by-line articles by students are featured in the December issue and co-editors John G. Gruber, of Suitland High School, Maryland, and Dale E. Gerster, Bladensburg High School, Maryland, plan to continue running many student-written pieces.

Do your students have articles you can submit for them? A report on a science project, an essay on a science subject, a science drawing or cartoon—any and all of these are wanted. Send them in to *Tomorrow's Scientists* with the students' permission, of course, for their publication. And if in the press of the holiday season, you've neglected to mail your subscription orders, don't delay any longer lest your students miss an issue. A *minimum* of five subscriptions (50¢ each subscription for the 1956-57 issues) will start the publication coming into your classroom. You can, of course, always increase the order.

Roster of Sponsors

Two more names have been added to the roster of sponsors of the Future Scientists of American Foundation program. The total for 1956 is now 72. The newcomers since the November *TST* listing are:

The Johnson Foundation
Science Research Associates

Summer Programs

Two current major FSAF activities are geared months ahead to summer programs. One is the review now in process of the summer research assistantships for high school science teachers in college, university, and other institutional laboratories. Last summer's program was developed with 38 institutions and these as well as additional sources are being polled on prospects for 1957. It's all still in the development stage, but the outlook is favorable. If the college and university response is as encouraging as is anticipated, the program will be repeated next summer. Teachers' reactions are wanted, too. It's expected that full information on the program as well as application forms will go out to NSTA members and others early in the spring, possibly about March 1.

A second key activity geared to summer programs for science teachers is now being carried out by a special committee of two. They are Dr. Ned Bryan, of the School of Education, Rutgers University, New Brunswick, New Jersey, and Edwin Cooper, of Madison, New Jersey, High School. They are making a study of practices and procedures used by industry in the summer employment of teachers.

The results of the study will be published, probably in booklet form, early in 1957. It's anticipated that the report will be another form of assistance and encouragement to industry in broadening and strengthening the link between science education and work in the field. At the same time, the study should help expand the opportunities for this summer employment of teachers. For teachers, this would mean an increased chance for the type of experiences that help make teaching more meaningful.

SAA

Talk about the editorial content of *Tomorrow's Scientists* points up an interesting fact in relation to the program of Science Achievement Awards for Students. Two of the articles in the first issue were reports on projects which won awards in the SAA program. And two of the three student-written bylined articles in the December issue were also the results of SAA-award projects. The fact that the SAA program is nation-wide is reflected in the areas in which these student-authors live. They come from Washington, D. C., Austin, Texas, and Atlanta, Georgia. Other regions will be represented in future articles.

So—if you have students who are interested in writing as well as science, here is an added incentive for their participating in the 1957 SAA program. Remember these key facts:

1. Entries must be *postmarked* not later than the deadline date of March 15, 1957.

2. Entries must be sent to regional chairmen, not to the NSTA office.

3. Entries must be the work of individual students; group entries are not acceptable.

Try these UNITRON *Student Microscopes*

. . . in your own classroom . . . FREE . . . for 10 days

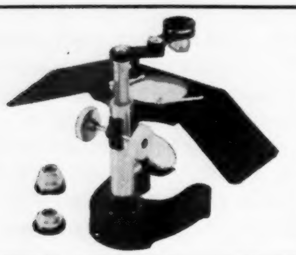
UNITRON Student Model MUS

Despite its low cost, UNITRON Model MUS offers features lacking even in much more costly models offered for student use. For example, both fine and coarse focusing are provided—not merely a single focusing control; an iris diaphragm to regulate aperture for highest resolution—not merely a disk diaphragm; and a condenser system for optimum illumination.

The optical performance of Model MUS at each of its magnifications is equivalent to that of expensive research models. All mechanical parts are made of the same fine materials as our microscopes for advanced work, machined to close tolerances and beautifully finished in black and chrome. A mechanical stage is available as a separate accessory. Both a fitted wooden cabinet and a plastic dustcover are included.

OBJECTIVES: Achromatic 5X, 10X and 40X.
EYEPIECES: Choice of two Huygens eyepieces, among 5X, 10X, 15X.

only **$74**
quantity discounts available



UNITRON Dissecting Model ADS

Here is an ideal dissecting microscope for your laboratory class. UNITRON Model ADS has a heavy horseshoe base with large 92x75mm stage with glass plate. The micrometric rack and pinion focusing mechanism has a travel of 45mm. A swivel-arm lens holder permits observation over a wide area. Achromatic lenses, detachable arm rests, mirror and white background plate, and fitted cabinet are included.

Model ADS with lenses for 10X, 20X . . . . **only $32.50**
Model ADSA with lenses for 5X, 10X, 20X . . . . **only $36.50**
quantity discounts available

UNITRON Student Phase Model MPEA

The phase microscope renders visible a large class of specimens, such as living cells, which are practically invisible under the ordinary microscope. No staining or special preparation of the specimen is required, and the microscope itself is operated in the usual manner. Every biology teacher needs at least one phase microscope to demonstrate processes in *living* organisms.

Phase microscopes are customarily available only in the $500-$1000 price range. UNITRON Model MPEA is the only phase microscope ever offered which is priced to appeal to the limited educational budgets. As Professor Corrington reported in *Nature Magazine*, "Now, for the first time, this equipment, the most important development in microscopy since oil-immersion objectives is within the reach of the amateur, the high school, and the college freshman laboratory." We should be happy to send you a reprint of his interesting article on request.

Model MPEA can also be used as an ordinary microscope by unscrewing the phase diaphragm. The microscope comes complete with cabinet.

OBJECTIVES: Achromatic 4X, P10X, P40X.
EYEPIECES: 8X, 15X.

only **$99**
quantity discounts available

UNITRON Microscopes are chosen by leading universities, such as—

Bates College	Tulane Univ.
Boston University	U. of Alberta
Bowdoin College	U. of Arkansas
Brooklyn College	U. of Buffalo
Brown University	U. of Houston
Columbia University	U. of Illinois
Cornell University	U. of Louisville
Creighton University	U. of Maine
Depauw University	U. of Miami
Harvard University	U. of Michigan
Hillyer College	U. of Miss.
Johns Hopkins Univ.	U. of Missouri
Kansas State College	U. of Nebraska
Louisiana State Col.	U. of Rochester
Loyola University	U. of S. Dakota
M. I. T.	U. of Tampa
Princeton University	U. of Tennessee
Simmons College	U. of Texas
Temple University	U. of Tulsa
Tufts University	Yale University

These UNITRON Student Models are part of a complete line of microscopes which includes laboratory, phase, stereoscopic, polarizing and metallurgical models. These remarkable instruments have dispelled the myth that unexcelled optical and mechanical performance is inconsistent with low cost.

We invite you to try any or all of the Student Models in your own classroom for ten days at no cost or obligation. Let the instrument prove its value to you *before* you decide to purchase. Send coupon below for your free UNITRON Microscope Catalog.

United Scientific Co. 204-6 Milk St. Boston 9, Mass.

Please send me your complete catalog on UNITRON Microscopes.

Name........................ Title........................

School........................

Address........................ City and State........................

ST-O

WESTMEYER—continued from page 397

5. Laboratory notes are kept and students hand in written reports of their work. These might include a general description of the work, notation of results, and some sort of interpretation. The steering committee could decide on some form for this report.

6. Certain days are devoted to laboratory work for everybody.

7. Certain days are devoted to work on individual projects, which gradually develop out of the early study and laboratory work.

8. Whenever it becomes apparent that some students are having difficulty with some phase of the work, a lecture is announced and those interested are invited to attend. If there are some who need the lecture but are reluctant to attend, they are given a special invitation.

9. After the group work, reports, assignments, and laboratory work in the chosen area are completed, the whole class is called into session for a summarizing discussion and this is followed by a test. After the test is discussed and extra help is arranged for those who still need it, the steering committee decides on the next subject.

10. Meanwhile, during available time in class and as a continuing out-of-class assignment, the students have been working on "element sheets." These are blank forms to be completed on some 30 or 40 elements concerning such things as atomic weight, valence, occurrence, physical and chemical properties, important compounds, uses, etc., and also including a space for "tests for the presence of the ion." When these have been finished, there is a series of summarizing sessions, especially on the last item. After this is completed, the class goes into a series of laboratory work periods during which they learn to analyze unknown chemicals for some of the easier cations and anions. This analysis of unknowns can be a most enjoyable and meaningful experience for both students and teacher.

This is a sort of climax to the study of general inorganic chemistry. From here on to the end of the year, always subject to the guidance of the steering committee, the class gets more and more into group and individual work. First, interest groups work as research teams to study a particular subject of interest to the members. This involves use of the laboratory, the library, perhaps resource persons, etc. The teacher meets with group chairmen and with groups to check on progress and to give help where it is needed. Meanwhile, individual project work is also going on as time allows.

Information is shared by reports, demonstrations, panels, and the usual techniques. Any subject that seems of general interest is investigated more thoroughly by the entire class.

Finally, any individual project work that seems of general interest is also presented to the class. The year is completed with this group and individual study, the work near the close being mostly individual.

This method embodies eight important points. (1) All class members receive instruction in all general chemical principles usually taught in such a course. (2) This, however, is done with dispatch and in such a way as not to dull natural interest, by using a lot of laboratory work and as little lecture as possible. (3) The students direct themselves, within a framework set partly by themselves and partly by the teacher. (4) In more advanced or more technical aspects, interest groups rather than the whole class do the work. (5) Still, all class members have a chance to get some learning in these areas through the sharing of information. (6) It allows for a lot of individual work and hence for a lot of individual help by the teacher. (7) The students learn laboratory techniques (they have to), by using the laboratory so much, and they also learn better to use resource material. And (8) this method is easy on the teacher. The students, properly, do the work.

EDITOR'S COLUMN—continued from page 381

be missing the boat, and here are some suggestions for getting back on the beam? Why do many teachers oppose or resist this kind of help? How much can summer workshops, conferences, and institutes help the science teachers who attend them? In what ways?

Next summer will see hundreds of thousands of dollars invested in programs hopefully designed to stimulate and lead to improvement in science teaching. If recent history repeats, most of these programs will stress increasing and updating the teachers' knowledge of subject matter. Relatively little attention or *planned* programming will be devoted to techniques of teaching and psychology of learning.

And so I come to my thesis: that we could well afford to invest a few thousand dollars in research, fact-finding studies, and conferences dealing with curriculum and instructional methods in science. I'm wondering whether you agree? Your answer and reactions, and those of your colleagues, should give us some interesting items for our "Readers' Column" in the next few issue of *TST*.

Robert H. Carleton

WALLEN—continued from page 400

encourage a greater degree of cooperation between state education departments and universities in giving an inclusive program of aid to the secondary schools.

In addition to the efforts already described, STIP is interested in and working on other facets of the science teaching improvement problem. For example, cooperative activity of STIP and the National University Extension Association (NUEA) has been initiated. A committee of NUEA will meet, with STIP support, to develop an approach to the problem of subject matter competence of teachers. This committee will survey the existing science and mathematics offerings by correspondence. An analysis of the present and projected use of these courses will be made and desirable action taken.

The common problem of the Future Scientists of America Foundation (of NSTA), Science Clubs of America, and the Junior Academies of Science of servicing high school students interested in science and mathematics has received considerable attention by personnel of STIP. The Junior Academies program had had little national coordination and support while the other two agencies have been active at the national level. An investigation is under way of the status of the several Junior Academies of Science with the idea of providing greater assistance to them. The Junior Academy program is being developed to supplement the activities of the other two organizations and to form a more inclusive scientist-sponsored program in all areas of science and mathematics.

A Junior Academy Session of the Academy Conference is being convened on December 28 during the AAAS meeting in New York to consider problems of effecting an improvement in the stature of the Junior Academies. A proposed conference in Oak Ridge, Tennessee in mid-January would develop plans to meet the needs as understood by a representative from each Junior Academy.

The staff of the STIP program feel that action in all of these and other areas of thought and practice are becoming essential functions of scientists of all kinds and degree. We feel that the occupational hazards of teaching should be reduced as much as possible and that the professional competence of teachers should be a continuing concern of all citizens.

Book Reviews

ENCOURAGING SCIENTIFIC TALENT. Charles C. Cole, Jr. 259p. $3.50. College Entrance Examination Board, New York. 1956.

Subtitled "A study of America's able students who are lost to college and of ways of attracting them to college and science careers," this book is an abbreviated version of a report submitted to the National Science Foundation in June 1955. The study was made at the suggestion and with the support of the National Science Foundation under contract with the publishers, the College Entrance Examination Board.

Dr. Cole, who is Assistant Dean of Columbia College of Columbia University, has done a thorough research job on the backgrounds of potential scientists and the factors that affect their decisions in either choosing or by-passing a career in science. He has made a particularly significant contribution in pointing out ways of increasing the size of the available pool of scientifically-trained individuals without lowering the average calibre of the individuals of which that pool is composed.

Dr. Cole is especially concerned with the loss of talented persons from high school to college and with ways of encouraging those with superior ability, particularly those with scientific talent, to enter institutions of higher education and to follow science careers. His research indicates that one-half of the top one-fifth in ability of American high school graduates throughout the nation do not go to college. About one-quarter of this group have aptitudes and interests that would serve them well in scientific careers.

The various means proposed by Dr. Cole to stem the loss of potential scientists range from increasing the number of scholarships to raising teacher salaries. He discusses the need for guidance counselors to give high school students a clearer picture of what a scientist is and what he does, so that science-talented youngsters, seemingly not interested in a college education, will have the facts on which to make an intelligent decision. Another proposal calls for an individual questionnaire study of high school students of five or six years ago who did not go to college; where the study indicated potential scientists, fellowships or part-time jobs could help induce the young men and women to enter college.

The section on conclusions and recommendations includes specific proposals on teacher encouragement, aid to schools, scientific careers for women, federal government policy, and research projects as well as general recommendations and scholarship aid.

Of particular interest to science teachers is Dr. Cole's introductory section on the nature and methods of science and scientific inquiry and the nature of scientific ability. Science teachers will also be interested in the sections on potential factors that encourage careers in science and the deterrents to the production of scientists.

The study includes an extensive, selected bibliography. The articles and books cited are arranged under general subject headings. It is this reviewer's belief that subsection headings would have helped the readers to understand more clearly the organization and contents of each section of the study. Section summaries also would have been useful to the reader who might not have the time to read the entire study with care.

Dr. Cole's study can be summarized with the following quotation taken from it: "If these deserving youths could be discovered and supported in their quest for higher education, the gain to our society each year would be incalculable. In terms of productivity it might represent five new inventions comparable to the electric light or television, or a dozen labor-saving devices. In terms of knowledge, understanding, perspective, and vision to cope with the complexities of the modern age, it would certainly mean a more enlightened, more effective segment in our population."

ABRAHAM RASKIN
Hunter College
New York, New York

GENETICS AND HUMAN HEREDITY. J. Ben Hill and Helen D. Hill. 526p. $6.50. McGraw-Hill Book Co., Inc., New York. 1955.

This text is designed for students in elementary genetics and so emphasizes basic principles. Since some of the more recent advances in this rapidly developing science are treated, the book is more extensive than some texts designed for beginners in this science.

Section 1 (chapters 1 and 2) constitutes a good treatment of the biological background and sets the stage for the succeeding chapters. There are 28 chapters, ten sections. The sections are developed as units, permitting some change in the order of presentation at the will of the instructor. This also allows for the omission of certain chapters or of entire sections when time does not permit a more complete study.

Examples and problems are taken from both the plant and the animal kingdoms, and the text will appeal to the student of botany as well as to the student whose greater interest is zoology. The illustrations are excellent and well chosen. There are numerous references for additional study listed at the close of the chapters. One of the best features of the text is the wealth of problems included, more than 500 in all. Although the title of the text includes "Human Heredity," this should not lead one to believe that this feature constitutes a large part of the book. Human heredity is well treated in approximately ten per cent of the text.

F. A. HANAWALT
Professor Emeritus, Dept. of Biology
Otterbein College
Westerville, Ohio

Audio-Visual REVIEWS

HOW OUR BODIES FIGHT DISEASE. Sound. $37.50 B & W. Encyclopaedia Britannica Films, 1150 Wilmette Ave., Wilmette, Ill.

Recommendation: Elementary and junior high school levels in science and health areas.

Content: The four most important ways in which the body defends itself against disease are shown in this film. The bodyguards are the skin, some of the mucous membranes, the lymphatic system, and the blood stream. Animated drawings demonstrate how the skin keeps out germs and the role of white blood cells in the lymph nodes. In conclusion, the film explains with both photography and drawings how the body produces antibodies after some diseases and how antibodies can be created artificially through immunization.

Evaluation: Good instructional qualities and understandable commentary. The drawings and animation are effective and help bring out the facts in regard to body defenses against disease. A teacher's guide comes with the film.

◇ ◇ ◇

WORMS TO WINGS. 12 mi. sound, 1954. $45 B & W, $90 Color. Moody Institute of Science, 11428 Santa Monica Blvd., West Los Angeles 25, Calif.

Recommendation: Junior high school 8th and 9th grade and senior high school levels in biology.

Content: Although the anise plant is a common sight in the fields and meadows of America, few people realize that this plant, with its delicate fern-like leaves, is host to the Anise Swallowtail butterfly. The film shows the four interesting stages of the insect's metamorphosis, from the egg to the larva, pupa, and adult stages.

Evaluation: Excellent content and color photography. Special effects contributing to the film's value include photomicroscopy and time lapse photography. A teacher's guide and commentary add to the film's effectiveness.

◇ ◇ ◇

FISH ARE INTERESTING. 10 min. sound. $50 B & W, $100 Color. Film Associates, 10521 Santa Monica Blvd., Los Angeles 25, Calif.

Recommendation: Upper elementary and junior high school levels in science, social science, or language arts areas.

Content: Photographed with the cooperation and under the technical supervision of Dr. Boyd Walter, Department of Zoology, and Sam Hinton, Curator, Scripps Institute of Oceanography, this film reports on various species of fish. Included are the glassfish, kelpbass, kelpbass eye, angelfish, garibaldis, platy, greenling, and croakers. Some of the facts pointed out by the film are that three-quarters of the earth's surface is covered with water and most bodies of water have fish in them, that fish are the most numerous of the backboned animals, and that the two largest groups are the sharklike and bony fishes.

Evaluation: An excellent film with fine photography from the viewpoints of color, movement, and the clarity of each specimen. The commentary is a valuable contribution to the film content. The sound of the croakers is hydrophonically recorded by the U. S. Navy. A teacher's guide is included.

◇ ◇ ◇

POLIO AND THE VACCINE. 44-frame filmstrip. Color. Free loan from local chapters of the National Foundation for Infantile Paralysis. Produced for The National Foundation for Infantile Paralysis, 120 Broadway, New York 5, N. Y.

Recommendation: Senior high school level and in health or physical training classes at elementary and junior high school levels.

Content: The filmstrip shows the various types of polio infection, the symptoms of the disease and treatment for its victims, and the production and testing of the Salk vaccine, which has been found safe and effective. As a result of years of research, the filmstrip points out, scientists have found a way to prevent paralytic polio. The filmstrip demonstrates how the Salk vaccine provides active immunity by stimulating the production of antibodies which attack the family of viruses that cause the paralytic polio.

Evaluation: A timely and factual filmstrip which, with the accompanying materials, should create interest and knowledge and enable people to better understand the symptoms of and treatment for the dreaded disease.

◇ ◇ ◇

FROGS AND TOADS. Sound. B & W. Young America Films, Inc., 18 E. 41st St., New York 17, N. Y.

Recommendation: Grades 7 through 12 in general science and biology areas.

Content: The film depicts the life cycle and life processes of frogs and toads and shows their adaptations for food-getting, self-protection, and preservation of the species.

Evaluation: Good commentary and sound, fair photography. The film stimulates interest and is rated good to excellent for school use.

◇ ◇ ◇

SPIDER ENGINEERS. 15 min. sound. $60 B & W, $120 Color. Moody Institute of Science, 11428 Santa Monica Blvd., West Los Angeles 25, Calif.

Recommendation: Upper elementary and junior and senior high school grades.

Content: Four typical species of spiders are dealt with in this film—the orb-weaver or garden variety, the diving spider, the trapdoor spider, and the bolas, so named because of its resemblance to a kind of lariat used in Argentina.

Evaluation: Excellent photography, color, and content; very good narration. This is a timely and effective film. A teacher's guide is included.

◆ ◆ ◆

THE BUMBLEBEE. Sound. \$55 B & W, \$100 Color. Murl Deusing Film Productions, 5325 W. Van Beck Ave., Milwaukee 19, Wis.

Recommendation: Upper elementary and junior and senior high school levels in biology and botany areas.

Content: The film presents a report on the bumblebee which can be effectively used in the study of insects and/or flowers as well as in general science.

Evaluation: Excellent sound and photography, very good organization, and good commentary. The film rates high in suitability for school use.

◆ ◆ ◆

BUTTERFLY MYSTERY. 10 min. sound, 1956. \$45 B & W, \$90 Color. Moody Institute of Science, 11428 Santa Monica Blvd., West Los Angeles 25, Calif.

Recommendation: Elementary and junior high school grades in natural science areas.

Content: Telling the life story of the Anise Swallowtail butterfly, the film describes its four stages of growth—the egg, the caterpillar, the chrysalis, and the adult. The details of each stage are carefully presented. The interesting manner in which the caterpillar spins its loop of silk by which the chrysalis is to be suspended as well as the amazing way the chrysalis blends with its background are sequences of merit.

Evaluation: Excellent color photography which adds to the value of the film.

◆ ◆ ◆

THE CHAMELEON. 8 min. sound, 1956. \$80 Color. International Film Bureau, Inc., 57 E. Jackson Blvd., Chicago 4, Ill.

Recommendation: Intermediate and junior high school levels in natural science areas.

Content: The chameleon's life is shown in color with excellent close-ups and some slow motion. Where the chameleon lives, how it hides, how its feet work, how its eyes work independently of each other, and the actions of its long tongue are graphically depicted. The sequences showing how the animal changes color in response to changes in light and temperature are particularly effective.

Evaluation: Excellent content and technical qualities; good subject coverage. This is a film to use in developing background, appreciation, and readiness for further study of the chameleon or closely-related animals.

◆ ◆ ◆

TEETH: THEIR STRUCTURE AND CARE. Sound. B & W, Color. Coronet Instructional Films, Coronet Bldg., Chicago 1, Ill.

Recommendation: Junior and senior high school levels in health and safety areas.

Content: Pointing up the value of care of the teeth and stirring interest in dental hygiene, the film gives a good personal case study of a young man who neglects to have his teeth checked until pain results when he eats sweets.

Evaluation: Good to excellent technical qualities, good instructional qualities, and generally good classroom values. A teacher's guide is included.

◆ ◆ ◆

WE USE POWER. 11 min. sound, 1956. \$50 B & W, \$100 Color. Churchill-Wexler Film Productions, 801 N. Seward St., Los Angeles 38, Calif.

Recommendation: Fourth through 7th grades in physical science and social studies areas.

Content: Grade school children are introduced to muscle power, wind power, water power, electric power, steam power, and the power of burning grass, in that order, by means of demonstrations of elementary experiments. The film also refers to atomic power in connection with the future.

Evaluation: Particularly effective for intermediate grades because of the nature of its commentary, its pace, and the simplicity of the experiments. An excellent teacher's guide comes with the film.

Volume XXIII, THE SCIENCE TEACHER

Index—February through December 1956

Author's Index

Topical Index

Education of Science Teachers

Information for Science Teachers

Instructional Suggestions, Methods, and Materials

Investigations, Research, and Fact-Finding Studies

NSTA Activities

Science Clubs, Fairs, and Exhibits

Science Course Content, Organization, and Curriculum

Tests and Evaluation of Outcome

Our Advertisers

You Can Depend on the GENATRON

● *The MODERN Electrostatic Generator*

THE CAMBOSCO GENATRON serves not only for classical experiments in static electricity, but also for new and dramatic demonstrations that are not performable by any other means. It exemplifies a modern method of building up the tremendous high voltages required for atomic fission, for nuclear research, and for radiation therapy.

Entirely self-exciting, the GENATRON cracks into action at the snap of the switch—whose only function is that of starting the motor drive. No auxiliary charging method is employed. Hence, despite an output measured in hundreds of thousands of volts, no hazard is involved, for the operator or for the observers.

An Output of 250,000 Volts—or More!

THE CAMBOSCO GENATRON is designed to deliver, in normal operation, a discharge of the order of 250,000 volts. That figure, a conservative rating, is based on many trials conducted under average conditions. With ideal conditions, a potential difference of 400,000 volts has been achieved.

Modern Design— Sturdy construction and ever-dependable performance distinguish the GENATRON from all electrostatic devices hitherto available for demonstration work in Physics. This powerful, high-potential source, reflecting the benefits of extensive experience in electrostatic engineering, has absolutely nothing but purpose in common with the old fashioned static machine!

NO FRAGILE PARTS—Durability was a prime consideration in the design of the GENATRON which, with the exception of insulating members, is constructed entirely of metal.

The only part subject to deterioration is the charge-carrying belt, which is readily replaceable.

NO TRANSFER BODIES—In all conventional influence machines, whether of Holtz or Wimshurst type, electrical charges are collected and conveyed (from rotating plates to electrodes) by a system of "transfer bodies." Such bodies have always taken the form of metal brushes, rods, button disks or segments—each of which, inevitably, permits leakage of the very charge it is intended to carry, and thereby sharply limits the maximum output voltage.

It is a distinguishing difference of the GENATRON that electrical charges, conveyed by a non-metallic material, are established *directly upon the discharge terminal.* The attainable voltage accordingly depends only upon the geometry of that terminal and the dielectric strength of the medium by which it is surrounded.

Unique Features of the CamboscO Genatron

DISCHARGE TERMINAL Charges accumulate on, and discharge takes place from, the outer surface of a polished metal "sphere"—or, more accurately, an oblate spheroid.

The upper hemisphere is flattened at the pole to afford a horizontal support for such static accessories as must be insulated from ground. A built-in jack, at the center of that horizontal area, accepts a standard banana plug. Connections may thus be made to accessories located at a distance from the GENATRON.

CHARGE-CARRYING BELT To the terminal, charges are conveyed by an endless band of pure, live latex—a CamboscO development which has none of the shortcomings inherent in a belt with an overlap joint.

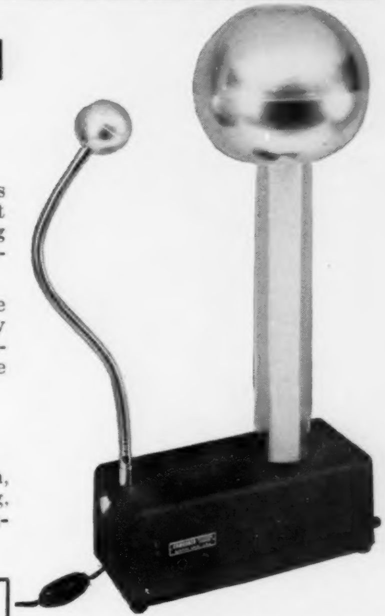
DISCHARGE BALL High voltage demonstrations often require a "spark gap" whose width can be varied without immobilizing either of the operator's hands.

That problem is ingeniously solved in the GENATRON, by mounting the discharge ball on a flexible shaft, which maintains any shape into which it is bent. Thus the discharge ball may be positioned at any desired distance (over a sixteen-inch range) from the discharge terminal.

BASE...AND DRIVING MECHANISM Stability is assured by the massive, cast metal base—where deep sockets are provided for the flexible shaft which carries the discharge ball, and for the lucite cylinder which supports, and insulates, the discharge terminal.

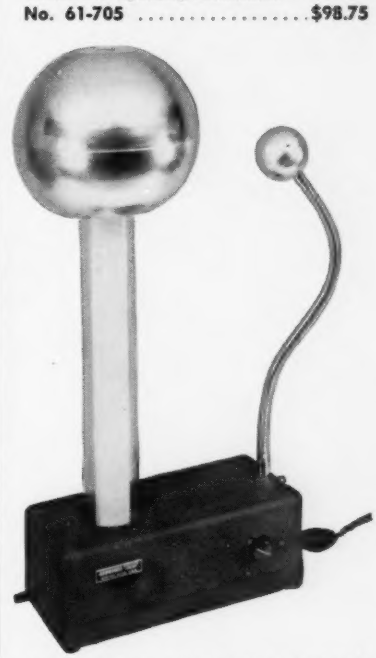
The flat, top surface of the base, (electrically speaking), represents the ground plane. Actual connection to ground is made through a conveniently located Jack-in-Head Binding Post. The base of the Genatron encloses, and electrically shields, the entire driving mechanism.

PRINCIPAL DIMENSIONS The overall height of the GENATRON is 31 in. Diameters of Discharge Ball and Terminal are, respectively, 3 in. and 10 in. The base measures 5¼ x 7 x 14 in.



GENATRON, WITH MOTOR DRIVE
Operates on 110-volt A.C. or 110-volt D.C.
Includes: Discharge Terminal, Lucite Insulating Cylinder, Latex Charge-Carrying Belt, Discharge Ball with Flexible Shaft, Accessory and Ground Jacks, Cast Metal Base with built-in Motor Drive, Connecting Cord, Plug, Switch, and Operating Instructions.

No. 61-705 .... $98.75



GENATRON, WITH SPEED CONTROL
Includes (in addition to equipment itemized under No. 61-705) built-in Rheostat, for demonstrations requiring less than maximum output.

No. 61-708 .... $109.00

No. 61-710 Endless Belt. Of pure latex. For replacement in No. 61-705 or No. 61-708 .. **$3.00**

CAMBOSCO SCIENTIFIC COMPANY

37 ANTWERP ST. • BRIGHTON STATION • BOSTON, MASS.